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A STUDY OF INVESTIGATION-DERIVED
WASTE MANAGEMENT OPTIONS

THESIS

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AFIT/GEE/ENV/93S-1

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AFIT/GEE/ENV/93S-11

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THESIS

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The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

Preface

The purpose of this study was to identify the status and the need for improvement of investigation-derived waste (IDW) management. IDW, as a consequence of Installation Restoration Program (IRP) investigations, will likely proliferate as the USAF strives to meet its clean-up goals.

The information disclosed in this study may be used by base-level IRP managers to determine if current IDW management methods sufficiently protect human health and the environment and comply with environmental laws. It may also be used to identify the need for changes in current practice to meet protection and compliance needs. The information is generally applicable to all federal facilities.

This study could not have been accomplished by an individual effort. Correspondingly, a debt of gratitude to my advisor, LTC Mark Goltz and my readers, Dr. Kim Campbell and LTC David Murphy is acknowledged for their support and advice given over the course of the last sixteen months. Also, the contributions of the base-level environmental managers interviewed in this study are acknowledged. Especially, I thank my wife, Susan and my children, Benjamin Ross and Sarah Marie for their willingness to carry on as a single-parent family at home in Wyoming in my absence.

Barry C. Mountain

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ABSTRACT

USAF is dedicated to the clean up of past releases of hazardous substances at its bases under the Installation Restoration Program (IRP). Clean up decisions are based upon data produced from investigations. Large amounts of waste may be derived from investigations. Investigation-derived waste (IDW), especially that with a hazardous component, may pose significant health protection and regulatory compliance problems if neglected. This study identifies the status and the need for improvement of IDW management to avoid those problems.

Information on the background of IDW management was collected through a review of environmental laws, waste management regulations, and existing guidance. Practical IDW management information was gleaned from conversations with IRP managers at twelve USAF bases around the country.

This study revealed that IDW management needs improvement. All bases acknowledged IDW concerns and have adopted various methods to deal with them. However, current methods appear to rely more upon expediency rather than permanence. This study showed that critical protection and compliance issues are being overlooked. Development of specific IDW management guidance may better assure that critical issues are addressed.

A STUDY OF INVESTIGATION-DERIVED WASTE MANAGEMENT OPTIONS

I. Introduction

General Issue

The United States Air Force (USAF) is pursuing its commitment to restore the environment at bases across the United States. Environmental restoration at federal facilities is conducted under the Department of Defense (DOD) Installation Restoratior Program (IRP). USAF environmental restoration managers use the IRP to identify, investigate, and remediate past releases of hazardous wastes at hundreds of bases across the United States (DOD, 1992:1,2).

Contaminated site investigations conducted under the IRP rely upon intrusive physical sampling methods. Intrusive physical sampling methods such as drilling, boring and excavating are employed to collect soil and ground water specimens for chemical analysis. These methods often comprise the majority of investigation activities used in the Site Inspection (SI) and Remedial Investigation (RI) phases of the IRP (DAF, 1989:61,65; 1992:Sec 5,23,41).

While advantageous in terms of site data production, intrusive physical sampling has a distinct disadvantage -- waste accumulation. Waste, consisting of potentially contaminated liquids, solids, and disposable supplies and equipment, accumulates at the IRP site as a result of sampling.

This excess liquid and solid material is a consequence of removing the intervening material to reach the soil and ground water zones which are to be sampled. Disposable supplies and equipment, including Personal Protective Equipment (PPE) and sampling tools, are also discarded as waste resulting from decontamination procedures. All waste, contaminated or otherwise, derived from IRP site investigations is known as Investigation-Derived Waste (IDW)(USEPA, 1991:1).

Depending on its specific content, IDW may be subject to solid and hazardous waste regulation and may be regulated under the provisions of one or more of the following laws: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA) [including both federal and state underground injection control (UIC) regulations], Clean Water Act (CWA), Toxic Substances Control Act (TSCA), and other state environmental laws (USEPA, 1992:3). Because IDW may be subject to various environmental laws, base-level IRP managers must make IDW management decisions which comply with all applicable laws (USEPA, 1991:3-11).

Environmental laws require IDW to be controlled to ensure that human health and the environment are protected. This requires IRP managers to control IDW to prevent unnecessary exposure while assuring that the methods used comply with federal and state laws. Consequently, base-level IRP managers seeking to effectively manage IDW must cope with a wide variety of complex technical and regulatory issues.

Effective IDW management is attained when base-level IRP managers can consistently protect human health and the environment, while meeting all regulatory requirements. This must be accomplished within remedial action schedules and budget constraints. Failure to comply with regulatory requirements may lead to fines up to $50,000 (Arbuckle and others, 1991:437).

Effective IDW management may play a significant role in the achievement of the USAF goal to clean up its bases by 2000 (Perini, 1991:20). With over thirty-five hundred active IRP sites at three hundred thirty-one USAF installations due to be investigated, the potential for IDW generation is vast (DOD, 1992:6). The USAF must assess the impact of IDW upon the IRP to anticipate problems and avoid disruptions that may occur from a lack of proper planning.

The purpose of this study is to identify the status and the need for improvement of IDW management. The study will reveal whether a significant IDW problem exists. Also, recommendations will be made to help base-level IRP managers better manage IDW.

Specific Problem

IDW generated at IRP sites may pose health protection and legal compliance problems. Additionally, accumulated IDW may attract unwanted regulator attention and erode needed public support.

While the potential to produce vast quantities of IDW exists, the status and suitability of current IDW management methods is unclear. Doubtless, many base-level IRP managers engaged in investigation activities have generated IDW. Yet, little has apparently been published regarding IDW management.

Research Questions

Identification of the status and the need to improve IDW management depends upon answering the following questions:

1. What is the extent and nature of IDW generated by IRP investigations?

2. Which federal environmental laws and DOD/USAF regulations apply to IDW?

3. How are base-level IRP managers currently managing IDW?
   a. Has adequate guidance been provided?
   b. Do current management methods meet IDW regulatory guidelines.

4. What solid waste and hazardous waste management options, including minimization, can be applied to IDW?

Research Scope and Limitations

The information collected to determine the status of USAF IDW management and support the identification of IDW management options will be drawn from federal environmental laws and regulations, DOD/USAF environmental regulations and waste management policies, base-level IRP managers, literature on solid and hazardous waste treatment and minimization and existing IRP contracts.

Since radiological and biological waste is rarely encountered during IRP investigation, they will not be included in this research.

The scope of the study will be limited to USAF bases within the continental United States. Bases that represent broad geographic diversity will be chosen from a number of commands to provide a representative fraction of USAF bases who are dealing with IDW as a part of the IRP.

Summary

This study examines the status of USAF IDW management. The information disclosed by this study is intended to help the USAF to identify its current IDW management capabilities and to anticipate future IDW management needs that will come with the increase in IRP investigations. Additionally, this study is aimed at assisting base-level IRP managers who seek timely and economical IDW management methods to reduce risk to humans and maintain compliance with environmental law.

II. Literature Review

Introductio

This hapter summarizes the literature available on the topic of Investigation-Derived Waste (IDW). This review seeks to establish the causes of IDW, and the existence, if any, of IDW management options. The outcome of this search will also help to determine the extent to which additional IDW management information will need to be collected from other sources.

The results of this literature review are reported in the following order: 1) IDW background, 2) IDW generation, 3) IDW identification, 4) IDW regulation and guidance, 5) IDW management, and 6) summary.

IDW Background

Investigation-Derived Waste (IDW) includes excess soil, water, and disposable supplies which are produced as by-products of environmental clean-up site investigations. IDW is generated by intrusive physical sampling activities conducted at sites where past hazardous waste releases are alleged to have occurred. The activities are conducted at Department of Defense (DOD) installations in conjunction with federal environmental law and Department of Defense (DOD) directives.

Compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 leads to IDW generation. CERCLA uses a problem-solving approach founded on investigation-derived data to clean up past hazardous waste releases at sites. CERCLA's strong reliance on soil and water data to characterize sites creates a need to conduct extensive sampling. Sampling that requires specimens from below the ground surface results in IDW generation.

The Defense Environmental Restoration Program (DERP) is the Department of Defense (DOD) equivalent of CERCLA. DERP contains procedures used specifically for the environmental restoration of federal facilities (US Congress, 1980:Sec 120; Hopper, 1989:98-99). It, too, places a strong emphasis on sample methods that generate IDW.

Presently, a major effort to clean up and close out 17,660 sites at 1,877 installations across the United States is underway using DERP (OASD, 1992). DERP is funded by the Defense Environmental Restoration Account (DERA). Recently, DERA has increased to meet the ever-growing demand for restoration funds (Perini, 1991:20-21; Grimes, 1991:9).

Figure 1 shows how rapidly the Defense Environmental Restoration Account (DERA) has increased over the past decade.

The USAF, in particular, has moved to clean-up hazardous waste releases at all its bases through

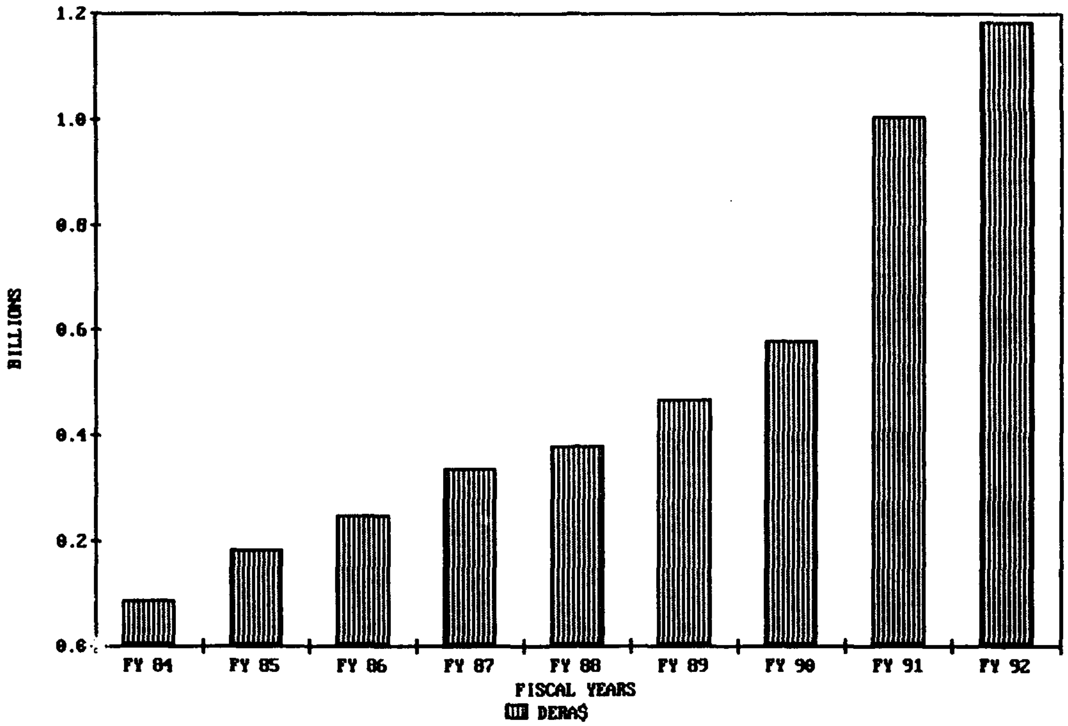

Figure 1. DEFENSE ENVIRONMENTAL RESTORATION ACCOUNT (DOD, 1992:27)

implementation of the Installation Restoration Program (IRP) component of DERP (Gabriel, 1984). According to Mr. Gary Vest, Deputy Assistant Secretary of the Air Force for Environment, Safety, and Occupational Health:

> To date, we've closed out 835 of the 4354 Air Force IRP sites. In the process, we've spent about $1.7 billion. Based on September '91 estimates, the total cost of cleanup for the Air Force IRP program is about $6.2 billion. Our goal is to have cleanup underway at all sites by the year 2000. (Graham, 1992:19)

This testimony clearly indicates that the level of IRP investigations will increase rapidly in the coming years.

The objective of the IRP is to identify, investigate and remediate past releases of hazardous waste (DAF, 1989:i). The IRP process is outlined in the following discussion with an emphasis on activities that have a potential to generate IDW. The stages of the IRP include: 1) Discovery and Notification, 2) Preliminary Assessment, 3) Site Inspection, 4) Remedial Investigation, 5) Feasibility Study, 6) Remedial Design, 7) Remedial Action, and 8) Site Closure.

Beginning with the Discovery and Notification, a report of an actual or suspected release of hazardous material is made to USEPA's National Response Center (Rudolph, 1993:Sec 1, 3-4;DAF, 1989:57-59). Normally limited to an administrative activity, no IDW is generated at this stage. The identification phase of the IRP proceeds to the Preliminary Assessment (PA) stage.

PA seeks to document all evidence of past releases of hazardous substances at a site. It examines a variety of recorded information to determine if the potential for contamination exists. Operation records, photographs, post-construction drawings, newspaper articles, and historical documents provide information about past hazardous substance releases. In addition, testimony and interviews are often used to collect information otherwise unavailable. Little, if any, activity that would produce IDW is conducted during the PA (DAF, 1989:59,61; 1992a:Sec 5, 21-22).

Based on PA findings, determinations are made that shape subsequent remedial efforts. Determinations for post-PA efforts may include: 1) implementation of a removal action if an imminent threat to humans is recognized, 2) progression to the next stage of identification, 3) initiation of the IRP investigation phase if it is obvious that remedial action is needed, or 4) termination of IRP activities because no evidence of a release was found (DAF, 1989:59-61; 1992a:Sec 5, 17-23)

Site Inspection (SI) usually follows the PA. It is the last step in the IRP identification phase. SI activities are directed at determining whether or not the contamination alleged by the PA actually exists. SI data collection activities target the area revealed by the PA to have been subjected to a release of hazardous substances. SI data collection activities commonly use visual observations and physical sampling. Physical sampling may use intrusive methods. Such methods produce IDW (USEPA, 1991:1). While SI data collection activities can be extensive, they are aimed at only proving or disproving the presence of contamination (DAF, 1989:61-62; 1992a:Sec 5,22).

Conclusion of SI activities leads to several possibilities for further remedial activity. If a hazardous waste release is not verified, no further action is appropriate and remedial action ceases. On the other hand, if evidence of contamination is supported by the SI, a decision will typically be made to proceed with the IRP investigation phase (DAF, 1989, 1992b:Sec 5,31).

In contrast to the identification phase, the IRP investigation phase involves detailed characterization of contaminants found at the site (DAF, 1989:63-85). The IRP investigation phase begins with Remedial Investigation (RI). RI work enlarges upon SI work by examining the nature and extent of contamination in detail (DAF, 1992b:Sec 5,35). By rigorously sampling the site, contaminant concentration, distribution, and mobilization characteristics are established. Determination of these characteristics requires large amounts of data. Large data quantity requirements are often fulfilled by collecting specimens at many locations (DAF, 1992b:Sec 5,41-42). Consequently, RI has a significant potential to generate vast amounts of IDW.

Figure 2 shows the stages and phases of the IRP process in their usual sequence of occurrence. The SI and RI stages are highlighted to illustrate the IRP activities with a significant potential to produce IDW.

After initial RI activities begin producing samples, a data stream emerges to feed the second stage of the IRP investigation phase - the Feasibility Study (FS). FS uses initial RI sampling data to identify and screen alternatives useful as solutions to the contaminant problems found at the site. As intensive sampling produces more and more data, the site contaminant characteristics become well

Discovery & Notification

|

V

Preliminary Assessment/**Site Inspection**
(Identification phase)

|

V

Remedial Investigation/Feasibility Study
(Investigation phase)

|

V

Remedial Design/ Remedial Action
(Remediation phase)

|

V

Close Out

Figure 2. THE IRP/CERCLA PROCESS (DAF, 1992b:Sec 3,17)

established. When a sufficient number of alternatives have been developed to deal with the contaminants, RI activities are terminated. Occasionally, RI activities may be briefly resumed to fulfill an overlooked FS requirement (DAF, 1992b:Sec 5,54). The end of the investigation phase usually terminates IDW generation, as well.

The clean up phase of the IRP includes the Remedial Design (RD) and Remedial Action (RA) stages. Their primary objectives are to implement the preferred alternative selected in the FS and to ensure that the required clean up standards are met (DAF, 1989:88). While implementation of remedies can often produce tons of excavated material, neither of these stages normally engage in the type of activity that generates substantial IDW. Depending upon the method used, performance monitoring may generate small amounts of IDW until site closure.

Finally, the Site Closeout (SC) phase is a single stage event which deals exclusively with administrative matters related to the site. The key objectives of the SC stage are to ensure that the SC decision is documented, the public and the regulators are notified of the SC decision, concurrence by USEPA and the state is obtained, and delisting is conducted if the site was on the National Priority List (NPL)(DAF, 1989:97-100; 1992a:Sec 5, 99-100). Depending upon the terms of the SC, post-project monitoring may persist. Such instances would likely involve only periodic specimen collections from existing boreholes and monitoring wells. Consequently, little opportunity to generate IDW exists in the SC stage.

It has been shown that achievement of IRP objectives involves IDW generation. IDW generated as a consequence of site characterization, may be a potential source of hazardous substances. Hazardous substances, especially those which are included with waste, are subject to regulation under several environmental laws.

Environmental laws that influence IRP activities are called applicable or relevant and appropriate requirements (ARAR) (Rudolph, 1993:Sec 11,6). Among the criteria used to gage the success of IRP progress and IDW management is compliance with ARARs (DAF, 1992:1; USEPA, 1992:1; 1991:5). ARAR compliance may allow the IRP to proceed without interruption resulting from enforcement actions. ARARs that influence IDW generation and handling are discussed in later sections.

IDW Generation

IDW generation is a function of the location and type of specimen required. Surface samples are readily accessible and require little, if any, disruption to acquire. On the other hand, specimens that must be retrieved from deep within the earth require disruption of overlying material. Disruption of this nature is a main cause of IDW generation.

IRP site characterization depends on sampling data. While data may be gathered visually, it usually depends upon specimen collection (DAF, 1992:5-25). Specimen collection using intrusive physical sampling methods generates IDW.

Some IRP sites where potentially hazardous solids have been released may be characterized by data produced only from the analysis of surface specimens. Surface sampling is non-intrusive. It may only involve removal of a vial of ponded water or a scoop of soil from the surface. Little, if any disruption occurs and virtually no waste results.

At an IRP site where a spill has occurred, the contamination may have migrated to subsurface soils and into groundwater. Uncontaminated overburden, or material that prevents direct access to subsurface zones, has no value as a specimen. Nevertheless, uncontaminated overburden must be removed to gain access to contamination zones for specimen collection. Its removal by intrusive physical sampling has the potential to generate significant amounts of IDW.

Intrusive physical sampling methods employ mechanically or hydraulically powered equipment to deliver buried earth materials to the surface where field personnel collect specimens. Equipment especially suited to this task includes portable rotary drilling rigs and auger boring machinery (DOI, 1989:18; Corbitt, 1989:Sec 9, 79-80).

The depth and extent of groundwater contamination can be determined by construction of monitoring wells. Monitor well construction uses rotary drilling rigs or boring machines to remove a column of soil in order to place casing, gravel packing, and cement grouting (DOI, 1989:2-29). All of the drilled-out overburden becomes IDW.

Monitor well construction produces liquid IDW, as well. After the monitor well casing is set, packed, and grouted, the well is further developed by over-pumping (DOI, 1989:87). Over-pumping removes groundwater that contains high concentrations of suspended and dissolved solids. Some solids remain from materials added when the well is being constructed. This occurs when hydraulic rotary methods are supplemented with special admixtures of refined earth materials and commercial chemicals called drilling fluids or "drilling muds" (DOI, 1989:38). Over-pumping purges the well bore of all solids-laden water until the water produced exhibits consistent turbidity.

Additionally, over-pumping may be used during subsequent specimen collections. Collection protocols may require purging the well casing by over-pumping as many as three casing volumes. This action tends to homogenize the specimen and eliminate any confounding effects of the well itself (USEPA, 1986b:103). This practice may lead to significant liquid IDW production for each of the many possible sampling events.

Determination of the depth and extent of contamination of subsurface soils depends on samples which are highly representative of the subsurface structure. Rotary and boring methods can be used to produce cored specimens that represent soil structures in detail. Coring is accomplished with the use of a core barrel inside the drill pipe or hollow-stem auger. As the drilling bit at the end of the pipe or auger cuts a cylindrical hole into the earth, the material at the hollow center is forced into the core barrel (DOI, 1989:29-47). The process produces significant amounts of IDW by removal of material from the annular space around the core column, although the cored material itself is removed for analysis and is not considered IDW. Analyzed core material may be either returned to the USAF or retained by the analytical laboratory for disposal.

Excess liquids and solids produced as a result of intrusive physical sampling form the bulk of IDW found at clean up sites. In addition to this material, site workers may contribute a distinctly different type of IDW. Much of the Personal Protective Equipment (PPE) and some of the tools used by site workers are disposable. This material results in IDW that resembles domestic waste.

PPE and equipment that is not intended for disposal also leads to IDW when it must be decontaminated. Decontamination procedures use considerable amounts of water and surfactant to "wash down" drilling rigs, tools, and equipment before they can be reused. This liquid material produced in conjunction with site characterization also qualifies as IDW (USEPA, 1991:1,20).

IDW Identification

In order to properly deal with IDW, a means to identify it is important. Identification of IDW may be made by understanding its most significant features. To help manage IDW, IDW may be categorized by its type and characteristics. Also of importance in managing IDW is the quantity generated.

Type. As noted previously, IDW largely consists of environmental media disturbed or produced by specimen collection activities. Media occurs in two basic forms -- solid and liquid. Solid-type IDW includes drill cuttings, core fragments, and soil specimen wastes. Liquid-type IDW consists of groundwater, decontamination fluids, and liquid specimen waste. Additionally, non-indigenous material may be discarded at the site in the form of clothing and equipment.

Solids. Solids may represent the bulk of IDW produced at a site. Solids are produced as a result of intrusive physical sampling at IRP sites. Solids emerge immediately at the ground surface as drilling and boring equipment churns the earth to produce specimens. The churned earth, known as cuttings, may consist of rock, gravel, and granular material along with a certain amount of moisture. While considered solid over a wide range of moisture content, the presence of groundwater in the bore determines how the cuttings appear as they emerge from the ground. Very low moisture content renders fine-grained soils powdery and coarser materials crumbly. Moderate moisture content causes many soils to have a gritty, yet plastic, consistency. Very high moisture content causes cuttings to appear as thin, rocky mud (Merritt, 1976:Sec 7, 11-12).

Liquids. Liquids are another type of IDW produced at IRP sites. Liquid IDW results when over-pumping is used to develop a monitor well or prepare it for specimen collection. It also occurs as decontamination fluids when water is used with cleansers and solvents to clean non-disposable tools, clothing, and equipment for subsequent reuse. While both types qualify as a liquid IDW, variations in chemistry, contamination, and dissolved or suspended materials often render the liquids completely dissimilar.

Non-indigenous. Besides environmental media, IDW may also occur as non-indigenous material such as excess clothing and equipment. Field personnel working at a site are often required to wear garments to prevent contact with the contaminated media. Garments such as caps, coveralls, and gloves are known as Personnel Protective Equipment (PPE). PPE that becomes contaminated, soiled, or damaged may become IDW if it is discarded at the site. Additionally, disposable equipment (DE) such as sample containers, towels, and utensils used for specimen collection may accumulate as IDW at the site (USEPA, 1992:1).

Characteristics. IDW may also be classified by its characteristics. Characteristics of IRP sites are established by the chemical analysis of soil and water specimens collected at those sites. IDW resulting from IRP investigations may share the characteristics of the site. Table 1 depicts the contaminants reported at installations undergoing IRP investigations within the Department of Defense in the first half of FY 1993.

Table 1. Contaminants Identified at Department of Defense Installations in FY 1993. (Hushon, 1993)

Contaminant	Installations Reporting
Lead	214
Benzene	191
Toluene	188
Trichloroethylene	169
Xylene	163
Ethyl Benzene	143
Arsenic	137
Zinc	101
Tetrachloroethylene	100
Barium	90
Chromium (VI)	90
Cadmium	85
Methylene Chloride	83
Copper	73
Chloroform	72
Nickel	72
Mercury	71
Vinyl Chloride	71
Acetone	67
Chromium (III)	66
Trichloroethane, 1,1,1-	65

In general, characteristics of IDW fall into two categories - hazardous or non-hazardous.

<u>Hazardous</u>. To merit a hazardous characterization, IDW must contain CERCLA hazardous substances (NARA, 1991:Part 302.4). Hazardous substances are defined as substances which because of their quantity, concentration, or physical, chemical, or infectious characteristics may 1) cause, or significantly contribute to, an increase in mortality or an increase in serious, irreversible or incapacitating reversible illness or 2) pose a substantial present or potential hazard to human health or the

environment where improperly treated, stored or disposed (Wentz, 1989:89; Masters, 1991:189).

Hazardous substances commingled with environmental media may be designated hazardous wastes. Due to the consequences of exposure to hazardous wastes, federal environmental legislation, known as the Resource Conservation and Recovery Act (RCRA), was passed to identify and regulate these wastes (Corbitt, 1989:Sec 2, 14). RCRA represents the culmination of several pieces of legislation dating back to the passage of the Solid Waste Disposal Act of 1965, which address the problem of waste disposal.

RCRA hazardous waste are identified by their names or by their characteristics. Wastes identified by their product or chemical names are known as "listed" wastes. If IDW does not contain a "listed" waste it may still be classified as a RCRA hazardous waste. IDW that exhibits one or more of four "characteristics" (ignitablity, corrosivity, reactivity, and toxicity) may earn a RCRA hazardous waste classification.

IDW may be classified as hazardous waste in other ways. If, as solid waste, IDW becomes mixed with any listed waste, the "mixture rule" requires that the mixture be managed as hazardous waste. The "derived-from rule" also applies to the classification of IDW as a hazardous waste. Under this rule, a waste that is generated from the treatment, storage, or disposal of hazardous waste (e.g., ash, leachate, drill cuttings) is also a hazardous waste unless exempted. If the waste is derived from a "listed" hazardous waste, it is considered hazardous waste until delisting procedures are followed. If the waste is derived from "characteristic" hazardous waste, it is not hazardous unless it exhibits that characteristic (Arbuckle and others, 1991:415).

Non-hazardous. To earn a non-hazardous characterization, IDW must meet the requirements of solid waste and not be classified as a hazardous waste. USEPA has defined solid waste to be any discarded material which is abandoned, recycled, or considered inherently waste-like (Arbuckle and others, 1991:410; DAF, 1992b:Sec II,4). Intentionally broad, this definition is designed to encompass all material phases including solids, liquids and gasses. Consequently, all types of IDW may qualify as solid waste.

IDW characterizations need only consider the scope and purpose of the study under which the IDW was produced. For instance, IDW generated from SI work that intended to prove or disprove the presence of liquid hydrocarbons in the soil needs only to be characterized in terms of that contaminant. Because verification of the presence of liquid hydrocarbons may be accomplished by smell, it may be unnecessary to conduct a detailed soil chemical analysis of the specimen. Accordingly, IDW produced to collect the specimen may be characterized by the same criteria. At the RI stage, when more information is available, more precise characterizations may be possible and must be made (USEPA, 1991:20).

Quantities. The quantity of solid and liquid IDW produced depends upon the specimen collection method and the extent to which it is employed. Intrusive methods that displace material by drilling or boring generate significant quantities of IDW. Even in reaches where contamination does not exist, the drilling and boring action may mix uncontaminated environmental media with media that contains hazardous substances as it moves toward the surface. After the bore is completed, liquid IDW may also be produced as the well is developed by over-pumping. Additionally, liquid IDW quantities may increase with successive sampling events.

Monitor wells are widely used to provide groundwater elevation data and easy access for groundwater specimen collection. Monitor well construction is a significant source of IDW, however. The quantity of IDW produced is a function of the depth and diameter of the monitor well bore.

Monitor well depth is dictated by the location of the contamination zone(s) below the surface. Monitor well bore diameter is partly determined by the size of the pump needed to retrieve groundwater specimens from the well. Otherwise, the well must be constructed large enough to allow for groundwater infiltration. This leads to boring the well two to three diameters larger than the diameter of the pump. Oversizing the bore allows for proper alignment of the casing that encloses the pump and the packing around the casing necessary to admit water (DOI, 1989:91; USEPA, 1986b:73).

Borings constructed for the sole purpose of soil specimen collection may be much simpler and less prone to IDW generation. Soil specimens are normally taken to define spilled contaminant dispersion areas and penetration depth boundaries. Chemical analyses of several soil specimens collected from small borings, normally of 4-inch diameter, are often sufficient (DOI, 1989:51).

Figure 3 shows the potential rate of solid IDW volume generated for borings of various diameters.

To emphasize the potential for solid IDW production during monitor well construction, consider the following scenario: at IRP sites where groundwater contamination is suspected, monitor wells can supply data essential to the SI and RI. Local groundwater hydrology data may be obtained by placing monitor wells in a "one up-gradient, three down-gradient" pattern around the site. The four wells, each averaging 30 feet in depth, are bored at 12-inch diameters and cased for 4-inch pumps. The volume of solid IDW generated during their construction may weigh over four and one-half tons and might fill approximately seventeen 55-gallon drums three-quarters full (Parmely, 1981:123).

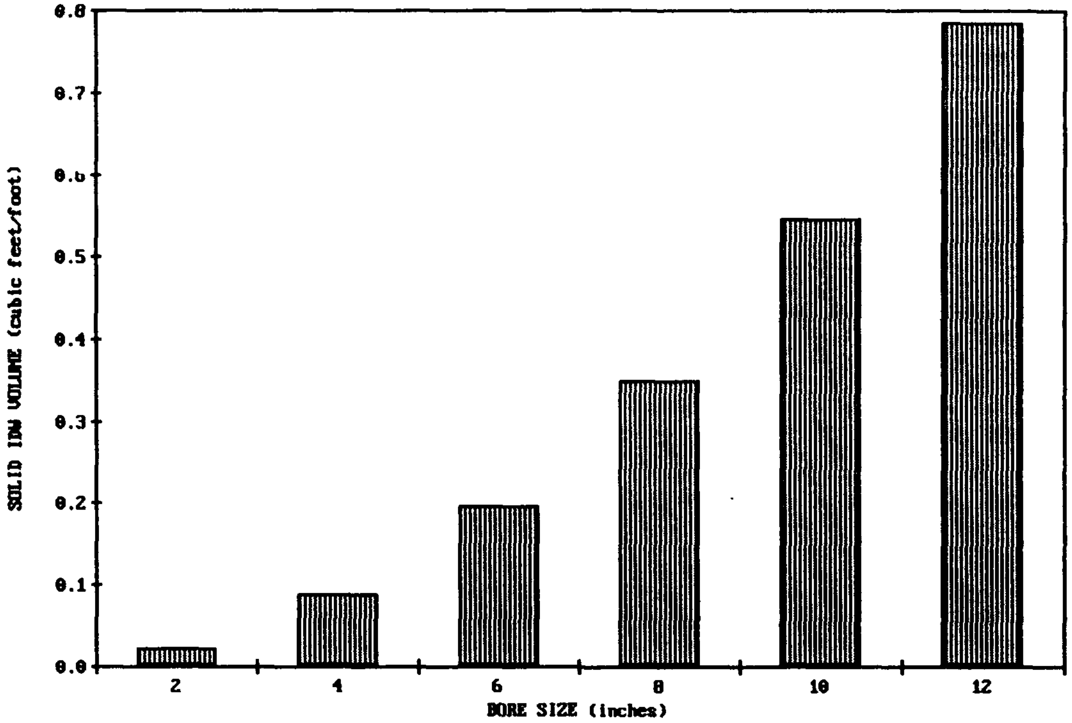

Figure 3. Solid IDW Volume as a Function of Bore Size

Liquid IDW resulting from monitor well construction may produce volumes comparable to solid IDW. Liquid IDW results from monitor well development techniques that rely on over-pumping to purge the newly constructed well of solids-laden, potentially contaminated groundwater.

After the well is developed, successive rounds of groundwater specimen collections may also contribute to the overall amount of liquid IDW generated. The water standing in a well prior to specimen collection may not be representative of in-situ groundwater quality. Therefore, standing water should be removed from the well so that formation-fresh water can replace the standing-stagnant water (USEPA, 1986b:102). Over-pumping monitor wells prior to specimen collection is used for this purpose.

Over-pumping is used to reduce turbidity, homogenize the distribution of dissolved and suspended material in the water, and eliminate the by-products of biological degradation accumulated since the last over-pumping event (DOI, 1939:87). Over-pumping normally proceeds until a significant change in water clarity is observed. Clearer water may indicate that stagnant groundwater has been replaced by formation groundwater.

Figure 4 shows the potential volume of liquid IDW generated for monitor wells with common casing diameters.

To emphasize the potential for liquid IDW production by groundwater specimen collection, consider the following situation: at many IRP sites where local groundwater chemical data may be obtained by collecting groundwater specimens from monitor wells. Specimen collection may occur on a quarterly basis. If four 4-inch diameter monitor wells, averaging twenty feet of standing water are purged of three casing volumes before each specimen collection, the amount of liquid IDW accumulated in one year may equal approximately six hundred twenty-five gallons. This volume of liquid IDW may weigh nearly two and one-half tons and would fill approximately sixteen 55-gallon drums three-quarters full (Parmely, 1981:124).

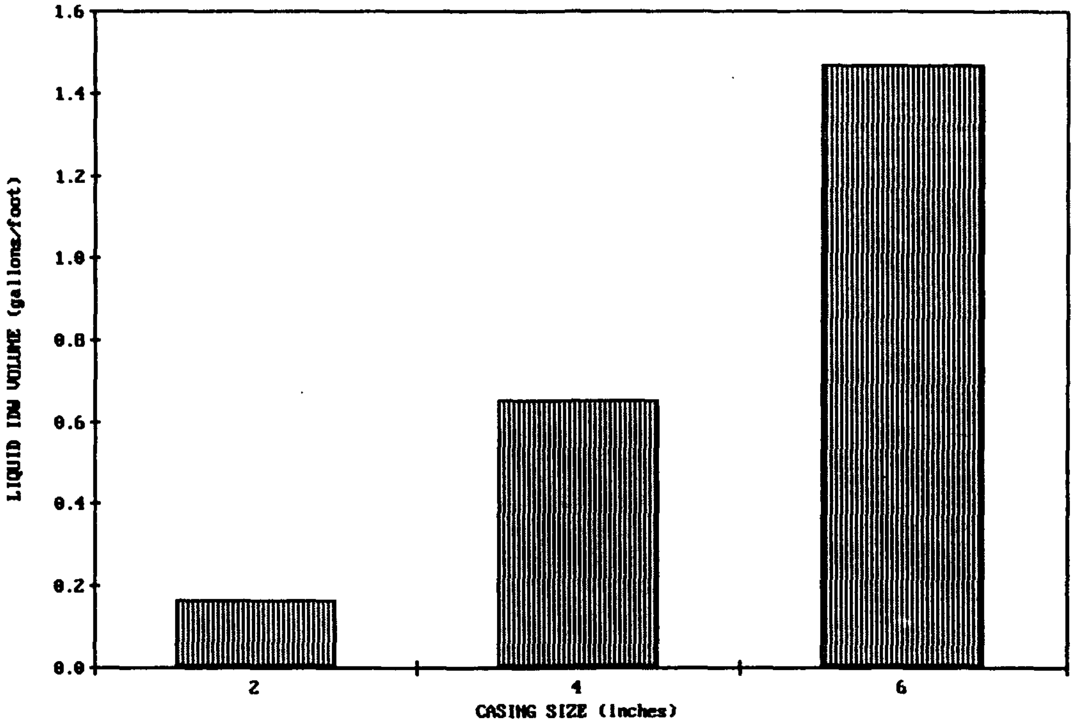

Figure 4. Liquid IDW Volume as a Function of Casing Size

IDW Regulation and Guidance

A variety of federal laws and USAF environmental regulations and guidance deal with solid and hazardous waste management and may be applicable to IDW management.

IDW Regulation. The incentive to manage IDW stems from existing federal and state (and sometimes local) environmental laws and DOD/USAF policy. Collectively known as ARARs, compliance provides protection of human health and the environment by regulating: 1) contaminant concentration and volumes, 2) environmental media affected (e.g.

groundwater, soil), 3) proximity and access of local populations to the site, 4) potential of exposure to site workers, and 5) potential of environmental impacts.

Among the ARARs that most influence IDW management are those which regulate its generation, transportation, and disposition. The following discussion describes CERCLA and the most prominent ARARs in terms of their influence upon IDW management. The ARARs discussed include: Resource Conservation Act (RCRA), Toxic Substance Control Act (TSCA), Clean Water Act (CWA), Department of Transportation (DOT) and state requirements, and USAF Pollution Prevention Program (P3P) policy.

<u>Comprehensive Environmental Response, Compensation, and Liability Act</u>. CERCLA requirements significantly affect IDW. Due to USEPA's determination that investigations, such as IRP site characterizations, constitute "removal" [CERCLA Section 101 (23)], the regulations that guide the implementation of CERCLA, known as the National Contingency Plan (NCP), apply. Under the NCP, all "removal" actions must comply with ARARs (NARA, 1991:Part 300.415).

The preamble to the NCP prescribes the following IDW management approach:

> "..... the field investigation team should, when handling, treating, or disposing of investigation-derived waste on-site, conduct such activities in <u>compliance with ARARs to the extent practicable, considering the exigencies of the situation</u>.

Investigation-derived waste that is transported off-site (e.g., for treatability studies or disposal) must comply with applicable requirements of the CERCLA off-site policy" (55 FR 8756, March 8, 1990)(emphasis added).

This means that IDW management is influenced not only by regulations but also by the circumstances surrounding the IDW's generation. Normally, waste is immediately subject to RCRA. However, RCRA compliance may be deferred for IDW retained on site for incorporation in the final CERCLA remedy. In this way, compliance will ultimately be met using a practical solution.

CERCLA Off-site Policy must be complied with for all IDW management options that include off-site disposal. CERCLA Off-Site Policy [OSWER Directive No. 9834.11 {November 13, 1987}] establishes criteria that site managers shall use to select a TSD. Shipments of IDW to out-of-state TSDs for disposal may be subject to additional ARARs. USEPA has adopted a policy [OSWER Directive 9330.2-07, {September 14, 1989}] to require generators to provide written notification to receiving states prior to shipments (USEPA, 1992:5).

<u>Resource Conservation and Recovery Act</u>. Because IRP site investigation work involves waste generation, RCRA regulation must be considered. This law is significant because IDW sometimes contains the hazardous substances that RCRA was designed to control. As noted by USEPA "Certain sections of the RCRA hazardous waste regulations may be

ARARs for IDW should RCRA hazardous waste be identified at the site" (USEPA, 1992:3).

IDW classified as solid waste or non-hazardous waste may be subject to management requirements under RCRA Subtitle D. Subtitle D regulates disposal of solid waste in facilities such as municipal landfills. Therefore, non-hazardous IDW such as decontaminated PPE or DE may be disposed of in a RCRA Subtitle D facility (USEPA, 1992:4).

In 1984, RCRA was amended by the Hazardous and Solid Waste Amendments (HSWA). The act intended to reduce the reliance upon landfill disposal of untreated hazardous wastes and to encourage the advanced treatment or recycling of wastes. This led to the imposition of Land Disposal Restrictions (LDR).

LDRs impacted waste management in three ways. First, USEPA banned land disposal of dioxin and solvents containing certain hazardous waste unless the wastes were pre-treated. Second, USEPA banned several hazardous wastes already banned from land disposal in the state of California. Third, USEPA published a ranking of all other hazardous wastes based on their intrinsic hazard and volume with a schedule for determining whether to ban the land disposal of such wastes one third at a time. Consequently, IDW containing RCRA "restricted" hazardous wastes will need to comply with the LDRs if planned to be disposed of off site.

Options that adopt on-site storage as the means to manage IDW may not need to comply with LDRs. By RCRA definition, storage occurs when waste is temporarily stored prior to treatment and disposal or final storage (US Congress, 1976:Sec 260.10). This alternative is an IDW management option for sites where IDW may be permanently disposed of as a part of the final remedy.

On-site storage may use one of several methods depending on the characteristics of the IDW generated. RCRA technical storage requirements which may apply to on-site IDW storage include:

Containers (NARA, 1991:Part 264-5 Subpart I)

1. Containers must be in good condition.
2. Wastes must be compatible with containers.
3. Containers must be closed during storage.
4. Containers must have a containment system.

Tanks (NARA, 1991:Part 264-5 Subpart J)

1. Tanks must have a secondary containment system.

Waste Piles (NARA, 1991:Part 264-5 Subpart L)

1. Waste piles must have leachate containment and removal.
2. Owners/operators must have a stormwater run-on system.
3. Owners/operators must have a stormwater run-off system.

In order for IRP managers storing IDW to avoid LDR requirements, it is important to avoid the appearance of land disposal. Land disposal of IDW at IRP sites (Area of Contamination [AOC] in RCRA terminology) may invoke additional requirements. Land disposal occurs when: 1) IDW from different AOCs are consolidated at one AOC, 2) IDW is moved from one AOC for treatment at another and returned, or 3) IDW is treated or held at the AOC where it was generated and then redeposited at the same AOC (USEPA, 1991:7).

Land disposal in its most elemental form is recognized as a RCRA hazardous waste management unit. Hazardous waste management units consist of the containers and the land or pad upon which it is placed [US Congress, 1976:Sec 260.10]. Because containerization alone does not constitute land disposal, LDRs may not necessarily apply as ARARs to IDW temporarily stored in containers. Furthermore, storing IDW on site until a final disposal option is selected by a ROD and implemented during a RA may be allowable under RCRA LDR storage prohibition (USEPA, 1992:3,4). Consequently, on-site storage of RCRA hazardous IDW may be a feasible way of avoiding LDR requirements.

If off-site disposal is preferred and IDW is determined to be a RCRA hazardous waste, "land disposal" is prohibited unless specific recordkeeping and treatment standards are met (USEPA, 1992:5). Additionally, LDR requirements must be verified on a facility-by-facility basis by the generator to assure that any hazardous waste contained in IDW is acceptable to the specific Treatment, Storage or Disposal (TSD) facility to which it is being sent.

Clean Water Act. The provisions of the CWA must be considered if aqueous IDW is planned to be disposed of in surface water. Water quality criteria, pre-treatment standards, and National Pollutant Discharge Elimination System (NPDES) requirements influence IDW management decisions involving surface disposal. While direct discharges to on-site waters are subject only to substantive CWA requirements, off-site release of aqueous IDW to Publicly-Owned Treatment Works (POTW) may also incur administrative CWA requirements, including permitting (USEPA, 1992:4; US Congress, 1981).

Toxic Substances Control Act. At sites where IDW contains polychlorinated biphenyls (PCB), the Toxic Substance Control Act (TSCA) must be considered in IDW management decisions. TSCA requirements regulate the disposal of IDW contaminated with non-liquid PCB at sample concentrations equal to or greater than 50 parts per million (USEPA, 1991:10). Additionally, TSCA limits on-site storage to one year for solid-phase IDW that contains PCB (USEPA, 1992:4; US Congress, 1989).

Department of Transportation requirements. IDW management must also consider DOT regulations as ARARs. In addition to the transportation requirements of RCRA, DOT's Hazardous Materials Transportation Act (HMTA) of 1975 requirements must be addressed as an ARAR to assure that materials, such as RCRA hazardous IDW, do not pose an undue risk to transporter personnel or the public. Efforts to provide this protection are coordinated and enforced by the

USEPA using regulations that control 1) identifying, 2) recordkeeping, 3) handling, 4) permitting, and 5) tracking of hazardous materials transported on public roads . State hazardous waste transportation programs must also be considered as ARARs to the extent that they are consistent with federal regulations. However, state programs that unreasonably restrict free movement of hazardous material across state lines may be pre-empted by DOT (Wentz, 1989:235-236).

State requirements. Promulgated state regulations that are legally enforceable, timely identified, and more stringent than federal regulations may be potential ARARs for IDW managed on site. Substantive requirements of state law that may be ARARs for IDW management include state water quality standards, direct discharge limits, and RCRA requirements (including underground injection control regulations) promulgated in a state with an authorized RCRA hazardous waste management program (as well as programs authorized by state laws). Off-site IDW management options may incur both substantive and administrative requirements of state environmental law (USEPA 1992:5).

Pollution Prevention Program policy (P3P). P3P affects IDW management in that it motivates IRP managers to minimize IDW generation (DAF, 1992c). While pledging to reduce potential sources of hazardous waste, P3P also promises to reduce solid waste. Because IDW may be defined as both hazardous or solid waste, a goal of IDW management should be to meet P3P objectives.

Summary. In general, CERCLA obliges IRP managers to identify the appropriate ARARs. The search for ARARs should include examination of RCRA, TSCA, CWA, and state requirements (USEPA, 1991:4). Depending upon the circumstances of the site and the nature of the IDW, CERCLA allows limited compliance. In particular, an IRP manager seeking to simplify IDW management may need only account for ARARs that relate to data-gathering activities rather than remediation activities to achieve adequate compliance. Careful attention to assure that data-gathering activities neither significantly change site conditions nor create an increased risk of exposure is often sufficient to maintain compliance (USEPA, 1991:3-4).

IDW Guidance. Specific guidance on managing IDW is scarce. Though the term IDW seems to have first been used by USEPA, little guidance has emerged from that agency. Only the two USEPA documents titled: 1) Management of Investigation-Derived Waste During Site Inspections and 2) Guide to Management of Investigation-Derived Wastes were found that specifically dealt with IDW (USEPA, 1991; 1992).

The first document outlines IDW regulatory requirements and policy concerns, means of identification, generation and management planning, management plan implementation, and handling costs. The document focuses on IDW generated during the SI phase of the IRP while completely neglecting any mention of IDW generated during the RI phase.

The second document is a fact sheet. It discusses IDW management requirements, including ARARs; IDW management objectives, emphasizing minimization and actions consistent with the final remedy; IDW disposal option selections, citing several examples; and community concerns related to IDW disposal activities. USEPA guidance offers only general objectives and limited specific options for USAF managers dealing with IDW issues at IRP sites (USEPA, 1991; 1992).

No specific reference to IDW was identified in a review of DOD and USAF environmental program publications. While the USAF IRP guidance documents, Air Force Installation Restoration Program Management Guidance and Installation Restoration Program Remedial Project Manager's Handbook, discuss broad restoration program procedures that produce IDW, no specific guidance is offered to manage IDW. USAF guidance for topics related to IDW management does exist, however.

The Air Force Hazardous Waste Management Guide is a primary source of information for USAF environmental managers. Developed as a training manual, this guide describes hazardous waste 1) management, 2) laws and regulations, 3) identification and characterization, 4) handling requirements, 5) record-keeping needs, and 6) generator responsibilities (DAF, 1992b).

To the extent that IDW may contain hazardous substances, USAF guidance may provide useful IDW management options. Hazardous substances mixed with environmental media from an IRP site may result in hazardous IDW. IDW that fits the criteria of RCRA hazardous waste qualifies as the type of waste that USAF guidance is designed to manage.

IDW Management

IDW should be managed to protect human health and the environment from harm resulting from exposure to substances contained in the waste and to comply with ARARs (USEPA, 1992:1). IDW is best managed by 1) minimizing the amount of IDW generated and 2) managing the remainder in a manner consistent with applicable environmental regulations and the final remedy for the site. Achievement of these objectives depends upon careful selection and implementation of IDW management options that are appropriate to the type and characteristics of the IDW generated.

The following discussion covers the 1) objectives of IDW management and 2) the options currently available for IDW management.

Objectives. As the scope of IDW has come into focus, one fact is clear; the preferred method of management is to minimize generation. Minimization of IDW enhances protection of human health and the environment and simplifies compliance with ARARs by reducing the overall amount of IDW generated. Minimization, especially of RCRA hazardous waste, may significantly reduce the need to meet IDW storage and disposal ARARs. This may result in significant cost savings and avoid enforcement actions (USEPA, 1992:5; 1991:20).

Minimization is defined as a reduction of either the volume or the toxicity of a waste which leads to resource conservation and environmental protection (DAF, 1992b:VIII-4; Sec I, 8). Minimization occurs when any source reduction, recycling, or reclamation activity results in the reduction of the total volume or toxicity of hazardous waste. The 1984 Hazardous and Solid Waste Amendments (HSWA) ar. USAF Pollution Prevention Program policy (P3P) support minimization by dictating that, whenever feasible, the generation of hazardous waste is to be reduced or diminished as expeditiously as possible (DAF, 1992b:Sec 5, 31).

Neither USEPA nor USAF have issued standards for minimization. USEPA allows generators to determine the most practical methods of waste minimization according to individual circumstances. RCRA provides opportunities for USEPA to monitor the performance of individual minimization efforts by requiring generators to identify, in their biennial reports to USEPA (or state), their efforts to reduce the volume and toxicity of waste generated and actual reductions in volume and toxicity achieved. In addition, generators are required to certify, on manifests accompanying off-site shipments, that a program is in place to economically reduce waste (DAF, 1992b:5-31).

According to USAF policy, each installation is required to adopt hazardous waste minimization to comply with Air Force Regulation (AFR) 19-11 and USEPA requirements. USAF P3P incorporates minimization of hazardous waste as one way to conform to policy. Although similar to RCRA requirements, P3P focuses on source reduction and material substitution as the primary means to accomplish hazardous waste minimization (DAF, 1992b:5-31,32).

Source reduction, as a minimization strategy, may be achieved by reducing the toxicity or volume of the waste produced. Toxicity reduction involves use of less or non-toxic materials in a process to diminish the degree of hazard associated with the excess material that results as waste (DAF, 1992:5-31,32). Because IRP investigations must encompass all hazardous substances, the opportunity to minimize hazardous IDW by substitution does not exist.

Volume reduction, as a means of minimization, involves generating no more waste than is necessary. Process modifications, recycling, and reclamation are key factors to hazardous waste volume reductions.

While recycling and reclamation of hazardous substances mixed with environmental media offers little minimization potential, modification of the IRP process by planning for IDW generation may provide an opportunity for minimization.

Proper planning of IRP identification and investigation field work permits activities that generate IDW to be compared to alternative techniques prior to their selection. Through adequate planning, such techniques as 1) replacing solvent-based cleaners with aqueous-based cleaners for equipment decontamination, 2) reusing equipment, 3) recycling contamination fluids, 4) limiting site traffic, 5) adopting non-intrusive investigation and collection methods that may generate less IDW and achieve minimization may be implemented (USEPA 1992:5).

IDW generation planning may be facilitated by the IRP process. The IRP process requires investigative activities to be conducted in a prescribed sequence according to documented procedures (DAF, 1989:1-10; 1992a:Sec 1, 1).

IDW may be minimized at IRP sites by anticipating the activities that result in its generation. SI and RI are the main IRP activities that produce IDW. Specimen-collecting events conducted under these two IRP stages have great potential to generate create significant amounts of IDW.

Typically, specimen collection activities prescribed in SI and RI work plan and Sampling and Analysis Plan (SAP) documents provide an insight into the potential for IDW minimization. SI and RI work plan documents show the locations and depths at which specimens are collected. Coupled with the investigation methods identified in the SAP, work plan information can be used to develop detailed estimates of IDW generation at each IRP site (DAF, 1992a:Sec 5, 26,42). Detailed estimates provide a basis upon which to balance specimen collection requirements with the amount of IDW that will be generated to fulfill them. Minimization may be achieved when the balance is optimized.

Segregation of IDW at the point of generation is another means of achieving minimization by avoiding inadvertent mixing of IDW at the site. Otherwise, a RCRA listed hazardous waste mixed with non-hazardous or uncontaminated environmental media may result in a combination classified by RCRA as a hazardous waste. Segregation of IDW, by its characteristics (as determined by field screening), may significantly minimize hazardous waste generation (USEPA, 1992:5; DAF, 1992b:5-33).

The best efforts to minimize IDW will seldom, if ever, eliminate its generation. Consequently, some IDW will almost always be generated. Most IDW, with the exception of non-indigenous IDW (e.g. decontamination fluids, PPE, etc.) may be considered part of the site if it remains at or near the point of generation (USEPA, 1991:7).

Whenever possible, IDW should be retained at the site and managed with other wastes from the site consistent with the final remedy. In this way, protection and compliance requirements which apply to the contaminated site may encompass the IDW generated to characterize the site. Managing IDW in this manner may avoid LDR requirements for separate treatment and disposal arrangements (USEPA, 1992:5).

Options. IDW management option selection involves a decision to engage in either 1) immediate disposal or 2) interim management of IDW. Immediate disposal, while more expedient, may be conducted on-site or off-site, often under rigorous regulation. Interim management is more prolonged but is often less complicated because it depends upon site storage until the final remedy for the site is implemented. Whichever choice is made, it is important that the decision suits the type of IDW generated and protects human health and the environment (USEPA, 1992:5). The following discussion describes: 1) the factors to be considered in IDW management option selection, 2) the options that are currently available, 3) the selection of the options.

Factors. IDW management options should be selected using best professional judgement and should take into account the following five factors:

1) Type and quantity of IDW
2) Risks associated with managing IDW on site
3) ARARs associated with managing IDW on site
4) Minimization of IDW
5) Consistency of IDW management with final remedy (USEPA, 1992:5)

Options. Table 2 illustrates the general options suggested by USEPA for managing IDW. The specific management option selected depends upon the type of IDW generated, its relative risk to humans and the environment, and other site-specific conditions.

According to table 2, three management options are applicable to all types of IDW. All may be handled by: 1) relocating IDW to an on-site treatment/disposal unit (TDU), 2) exporting IDW to an off-site TDU, or 3) storing IDW at the point of generation. Otherwise, IDW management options may be selected on the basis of type or characteristics such that: 1) soil and sludge/sediment may be returned to the point of generation; and 2) soil and aqueous liquids, if non-hazardous, may be spread around the site at which it was generated. Aqueous liquid IDW may also be managed by release to a POTW. Finally, some IDW management options are unique to specific IDW types. Where disposable PPE accumulates on a site, an option to discard it with solid waste exists subject to the availability of an industrial dumpster. In the case of decontamination fluids, evaporation may provide a simple solution (USEPA, 1991:19).

Selection. USEPA suggests that appropriate IDW management begins by planning for IDW generation with an emphasis on minimization before proceeding to handling the IDW that is generated. Then, management options are selected with regard to the characteristics of the IDW to be generated and the preference to either: 1) retain IDW on site or 2) export it off site. Figures 5, 6, and 7 illustrate the selection process.

Table 2. Investigation-Derived Waste Management Options (USEPA, 1992:2)

IDW MANAGEMENT OPTIONS

IDW Type	Generation Processes*	Management Options
Soil	Well/test pit Borehole drilling Soil sampling	Return to boring, pit or source immediately after generation Spread around boring, pit, or source within AOC+ Send to on-site TDU+ Send to off-site TDU+ immediately Store for future treatment and/or disposal
Sludge/ Sediment	Sludge pit/ sediment sampling	Return to boring, pit or source immediately after generation Send to on-site TDU+ Send to off-site TDU+ immediately Store for future treatment and/or disposal
Aqueous liquids (ground-water, surface water, drilling fluids)	Well installation/ development Well purging during sampling Groundwater discharging during pump tests Surface water sampling	Discharge to surface water Pour onto ground close to well (non-hazardous waste) Send to POTW+ Send to on-site TDU+ Send to off-site TDU+ immediately Store for future treatment and/or disposal

Decontamination fluids	Decontamination of PPE and equipment	Evaporation (for low concentration organic fluids) Send to on-site TDU[+] Send to off-site TDU[+] immediately Store for future treatment and/or disposal
Disposable PPE[+]	Sampling procedures or other on-site activities	Place in on-site industrial dumpster Send to on-site TDU[+] Send to off-site TDU[+] immediately Store for future treatment and/or disposal

* -- The generation processes listed here are provided as examples. IDW may also be produced as a result of activities not listed here.

\+ -- AOC: Area of Contamination (AOCs at a site may not yet have been identified at the time of the RI/FS); TDU: Treatment/disposal Unit; POTW: Publicly Owned Treatment Works; PPE: Personal Protective Equipment

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The process may be used in conjunction with the site managers best professional judgement to properly select appropriate IDW management options in the following manner: Upon determining (by observation or other screening methods) that IDW is either RCRA hazardous or RCRA non-hazardous, the IRP manager may elect to retain or export IDW (see figure 5).

If IDW is retained, a sequence of choices to conduct on-site management is provided in Figure 6 to properly handle particular types of IDW. Similarly, a corresponding sequence of choices to conduct off-site management of IDW is provided in Figure 7.

On-site Options. On-site IDW management options vary depending upon the types and characteristics of IDW. USEPA guidance states that RCRA non-hazardous IDW (soil and water) should always be considered for retention on site unless state ARARs or strong local concerns indicate otherwise (USEPA, 1991:25). Similarly, RCRA hazardous solid IDW (soil) may also remain at the site where it was generated. However, selection of either on-site management option must exclude testing or containerization. Avoiding those two management activities may prevent the appearance that IDW is being managed as a RCRA waste in a hazardous waste management unit (USEPA, 1991:vi,25). In that way, IDW management is less likely to be confused with more stringent RCRA land disposal requirements (USEPA, 1992:3).

USEPA expects hazardous or non-hazardous solid IDW (soil/sludge) to be returned to its source if short-term protectiveness can be maintained. This expectation acknowledges that non-hazardous IDW poses no exposure risk problems and presumes that similar problems associated with hazardous IDW will be addressed with the implementation of the final remedy at the site (USEPA, 1992:6).

USEPA has yet to state its expectations for on-site management of aqueous liquid IDW (groundwater). Consequently, management option selections for this type of

Plan for IDW minimization and handling

Characterize waste using available information and professional judgement

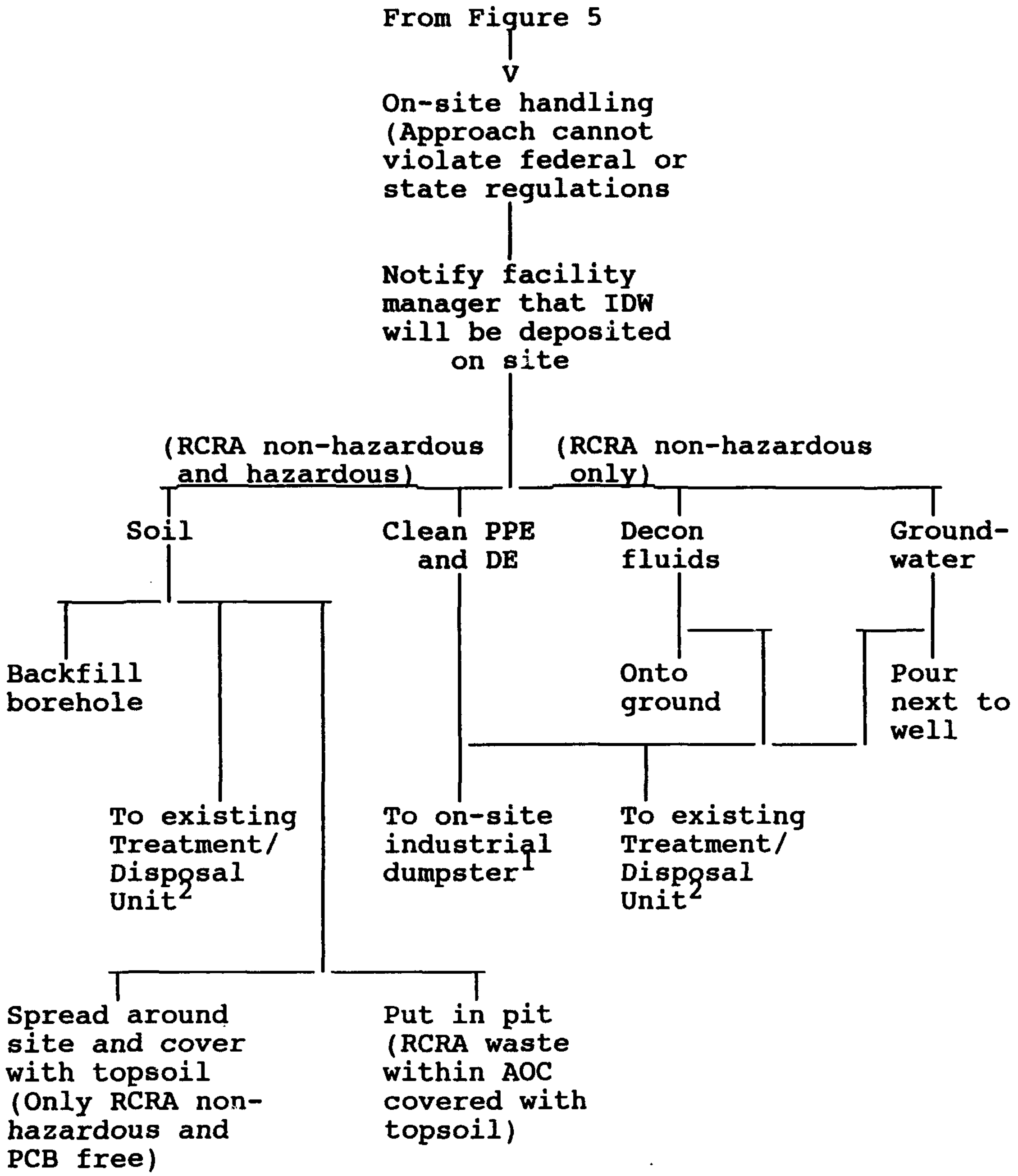
Determine if on-site handling creates increased risk at site

Plan for waste management according to IDW characteristics

- RCRA hazardous and high concentration PCB
  - Dispose[1] off site → See Fig. 7
  - Abandon[2] (soil only) on site → See Fig. 6
- RCRA non-hazardous
  - Dispose[3] on site → See Fig. 7
  - Abandon on site → See Fig. 6

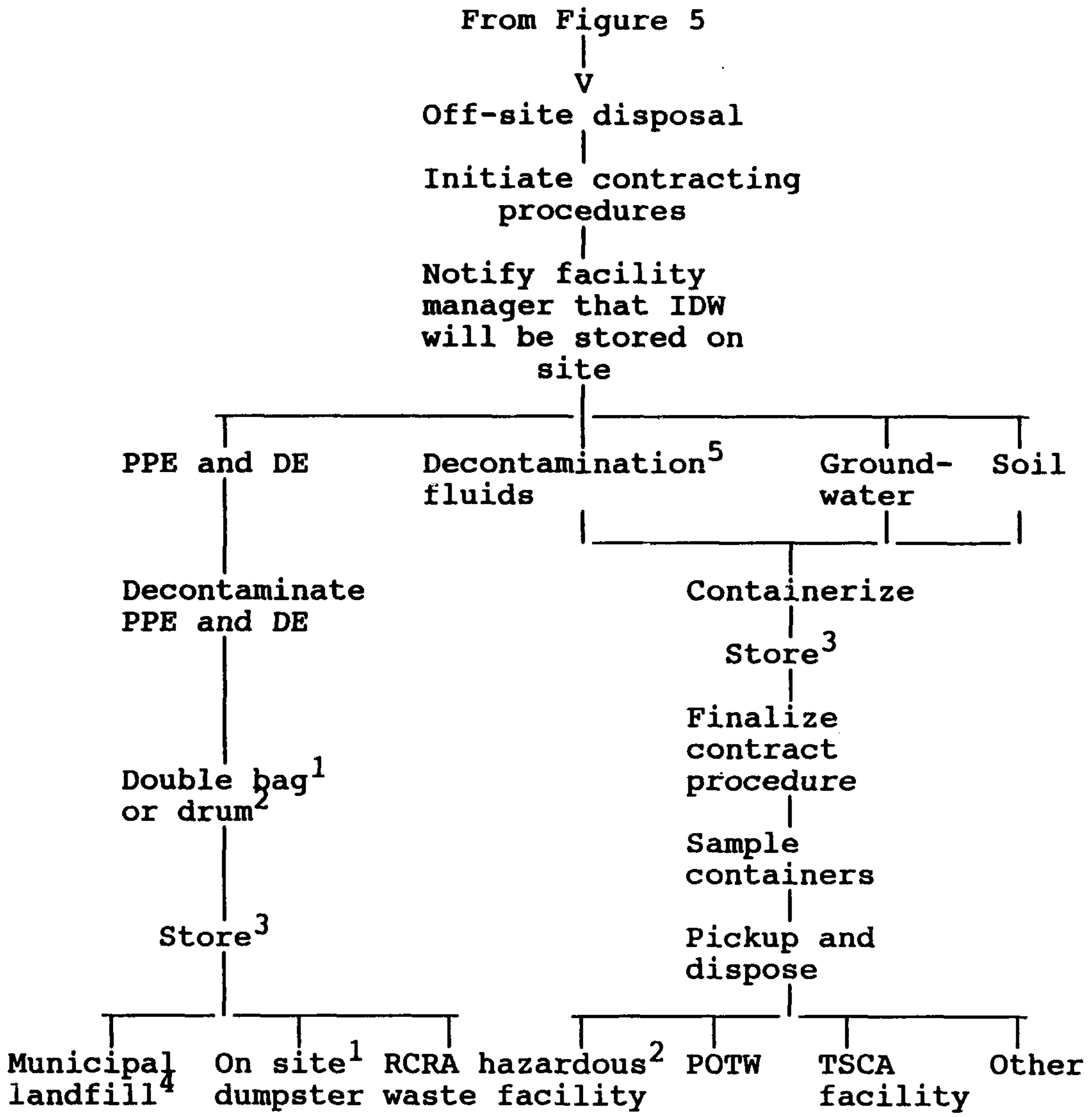
1 -- Soil cuttings, groundwater, and decontamination fluids determine anticipated waste quantity and applicable regulations for waste generators.
2 -- If not prohibited by other legally enforceable requirements such as state ARARs.
3 -- Justified only in rare circumstances when a RCRA non-hazardous waste is a state hazardous waste and state legally enforceable requirements call for waste removal, or if leaving the waste on site would significantly affect human health and the environment.

Figure 5. Investigation-Derived Waste Management Decision Tree (USEPA, 1991:22)



1 -- Clean PPE and DE may also go to the nearest landfill or to an USEPA warehouse dumpster.
2 -- If the receiving unit meets the off-site policy acceptability criteria.

Figure 6. Investigation-Derived Waste Management On-Site Decision Branch (USEPA, 1991:23)



1 -- Only RCRA hazardous waste.
2 -- Only RCRA hazardous waste generated in quantities greater that 100 kilograms/month when sent off site.
3 -- In accordance with accumulation requirements for RCRA hazardous waste.
4 -- Only if the conditionally exempt small quantity generator exemption applies.
5 -- If the conditionally exempt small quantity generator exception applies, off-site disposal of decontamination fluids may not require contract procedures.

Figure 7. Investigation-Derived Waste Management Off-Site Decision Branch (USEPA, 1991:24)

IDW are the responsibility of the site manager. Guidance suggests that, in the interest of exposure risk, site managers consider the following five parameters when choosing on-site IDW management options for aqueous IDW:

1) Volume of IDW
2) Contamination present in liquid IDW
3) Contamination present in on-site soil
4) Whether site surface or groundwater is potable
5) Whether groundwater is moving or contained

(USEPA, 1991:6)

USEPA guidance further suggests that non-indigenous IDW may either be stored until the final remedy is available or disposed of immediately. Contaminated non-indigenous IDW may not be disposed by pouring on the ground, however. Such an action may contaminate media that was not previous effected. RCRA hazardous non-indigenous IDW must be managed according to RCRA Subtitle C requirements. RCRA non-hazardous or non-hazardous non-indigenous IDW (PPE) may usually be disposed in an on-site dumpster (USEPA, 1992:6).

In general, USEPA recommends the following options for on-site management of non-hazardous IDW:

Soil:

1) Spread around well
2) ut back in boring
3) Put in a pit within an AOC at the site
4) Dispose at site TDU

Groundwater:

1) Pour onto ground next to well to allow infiltration
2) Dispose at site TDU

Decontamination fluids:

1) Pour onto ground (from containers) to allow infiltration
2) Dispose at site TDU

Decontaminate PPE and DE:

1) Double bag and deposit in a site or USEPA dumpster, or in a municipal landfill
2) Dispose at a site TDU

Selection of on-site management options for hazardous IDW must always regard protectiveness as a primary concern. Before deciding to leave RCRA hazardous IDW on site, a decision by the site manager considering the proximity of residents and site workers must be made. Site managers selecting on-site retention of hazardous IDW should plan to:

1) Delineate the site
2) Determine pit locations within the site
3) Cover pits with surface soils
4) Avoid containerizing or testing

(USEPA, 1991:25)

<u>Off-site Options</u>. Off-site IDW management options, illustrated in Figure 7, vary primarily by IDW type. Option selection depends upon the degree of protection desired or the amount of local concern generated. In cases where protection from exposure cannot be assured using an on-site option, off-site options may provide an expedient solution to IDW problems. Because off-site options almost always involve landfill disposal, these solutions often incur additional expenses and compliance requirements.

Off-site disposal of IDW is also presumed appropriate by USEPA when such a choice is consistent with the final remedy implemented at the site. Consequently, a final remedy that ultimately removes all contaminated media from a site provides suitable justification for IDW to be retained until such time that the remedy is implemented. In that way, IDW is removed with the rest of the contaminated media and compliance problems are handled on a one-time basis.

IDW retained on site and awaiting implementation of a final remedy may benefit from the selection of storage as a means of interim management. First, because all wastes will be exported from the site eventually, the IDW held in drums or piles is more convenient to load. Second, tightly drummed and properly piled IDW is not likely to threaten humans and the environment. Third, because off-site hazardous waste disposal may incur additional requirements (LDR, state ARARs, etc.) stored IDW may be handled concurrently with wastes from the remedial action.

Temporarily returning IDW to its source is another interim management option useful for IDW which ultimately will be incorporated in the final remedy. IDW may be returned to its source when protection of surface impoundments cannot be assured or when regulator policy or public concerns make it impractical to retain it on the surface (USEPA, 1992:6). Interim management of IDW bound for off-site disposal must take into account all concerns with regard to protectiveness, ARARs, and other relevant site-specific factors (e.g. weather, storage space, and public concerns/perceptions) (USEPA, 1992:5)

Off-site management options are recommended by USEPA when IDW includes:

1) RCRA hazardous water
2) RCRA hazardous soil that may pose a substantial risk if abandoned on site
3) RCRA hazardous PPE and DE
4) Any additional risk if abandoned on site (USEPA, 1991:26)

RCRA non-hazardous IDW may be disposed at RCRA non-hazardous waste disposal facilities that comply with CERCLA Section 121(d)(3) and CERCLA off-site policy when on-site options are precluded by state ARARs or other requirements.

USEPA recommends that planning for off-site IDW management should include the following four actions:

1) Notify the site manager of the possibility that containerized IDW will be temporarily stored at the site while awaiting pick up.

2) Initiate the contracting process to test, transport, and dispose IDW. Because RCRA hazardous IDW must go to facilities that comply with CERCLA Off-site policy, a list of the available facilities should first be obtained from USEPA. Site managers must check on the available facilities to determine that they are in compliance before IDW is picked up.

3) Coordinate IDW generation and pick up. IDW samples should be collected according to USEPA <u>Test Methods for</u>

Evaluating Solid Waste, Physical/Chemical Methods [USEPA publication SW846] and shipped for testing as soon as possible.

4) Acquire sufficient quantities and types of containers in which to place IDW. Drums may be used for small amounts or to segregate different types of IDW. Large quantities of solid and liquid IDW may be stored in tanks and bins. PPE and DE, decontaminated or otherwise, should be bagged or drummed prior to off-site transport for disposal (USEPA 1991:26-27).

USEPA expects that complying with these guidelines will limit on-site storage to, at most, the time required to complete any testing (usually 6 weeks) required by contractors in order to arrange for transportation. In most cases, this will not result in exceeding the RCRA 90 day storage limit. In cases where the regulatory 90 day storage limit is exceeded, the site manager must immediately move IDW off-site (USEPA, 1991:27).

Summary

IDW is a term used to identify the excess environmental media and disposable material that results from clean-up site investigations. Investigations conducted under the IRP have a significant potential to produce large quantities of IDW. Because of the potentially hazardous nature of the site, IDW produced by IRP investigations may pose risks to human health and the environment as well as create compliance problem with environmental laws.

Specimens of environmental media are analyzed to fulfill the chemical data needs of the IRP. Specimens are often collected by intrusive physical methods such as drilling and boring. Intrusive methods often disturb a significant amount of media to collect only small amounts of specimen. Excess media and other materials are designated IDW.

IDW is categorized by type and characteristics. Knowing IDW quantities is also important to managing IDW. Type classifications comprise three categories: solid, liquid, and non-indigenous. Knowledge of IDW type is important to anticipate control measures (e.g., drums, tanks). IDW characteristics include hazardous or non-hazardous depending upon the substances released at the site. Characterization is important to determine the degree of hazard that IDW presents and to determine the ARARs that it invokes. IDW volumes may influence decisions about short- and long-term disposition.

Several environmental laws, or ARARs, may regulate IDW because of its inherently waste-like nature and its potential to contain hazardous substances. Hazardous waste site clean up is addressed by CERCLA. Hazardous substances mixed with environmental media and non-hazardous waste are regulated by RCRA. IDW disposals that involve export to off-site facilities are regulated by CERCLA off-site policy and RCRA's LDRs. Other laws that may influence IDW may include: TSCA, when PCBs are present in IDW; CWA, when aqueous IDW is proposed for release to surface water or a POTW; DOT requirements, when off-site disposal entails transportation of hazardous IDW over public roads; and state requirements, where they are more stringent and do not contravene federal ARARs. In general, USAF P3P requires that hazardous wastes be reduced or eliminated.

Specific IDW guidance is in short supply. Other than two USEPA documents that state general objectives and limited specific options, little else is available. Existing USAF hazardous waste management guidance may be adapted to circumstances where IDW is classified RCRA hazardous and off-site disposal is preferred.

The two main objectives of IDW management are: 1) minimization of the amount of IDW generated, and 2) management of the IDW which must be generated in a manner consistent with applicable environmental regulations and the final site remedy. Minimization is facilitated during the development of several investigation activity planning documents as part of the IRP process. Otherwise, success depends upon the selection of IDW management options that afford protection of human health and the environment and comply with ARARs.

IDW management option selection is a process which begins by classifying the type and characteristics of the IDW at hand. Subsequent choices may be made by the IRP managers in accordance with protection and compliance needs.

III. Methodology

Introduction

This chapter describes the method used to locate, collect, and analyze the supplemental information necessary to answer the questions posed by the study. A detailed description of the method is offered to verify that the information was collected in a purposeful and scientific manner. The description covers: 1) method selection and justification, 2) population and sample identification, 3) instrument development and testing, and 4) data collection and analysis.

Method Selection and Justification

While the literature review of chapter 2 provided answers about the need and means to manage IDW, information about the practice and problems of IDW management may only be available from experienced individuals. The method adopted to collect that information depends on surveying.

Surveying allows USAF RPMs an opportunity to supply IDW management information by reporting their experiences. With their contribution, a realistic assessment of problems posed by IDW may be made. Similarly, surveying may reveal successful IDW management options which other USAF RPMs may use in their IRPs.

In order to gain first-hand knowledge of IDW management experience to support this study, telephone interviewing was adopted as the most appropriate style of surveying.

Population and Sample

Environmental management is a multifaceted discipline. Typically, individuals involved with environmental management in the USAF are exposed to a wide variety of environmental programs (Puetz, 1993). However, the individuals with the necessary expertise to assist with this study include only those USAF environmental managers experienced in environmental restoration activities.

Environmental restoration activities are authorized by federal law (US Congress, 1980:Sec 120). Individuals, known as Remedial Project Managers (RPM), have been designated to manage restoration activities (US Congress, 1980:Sec 104). By merit of their assigned responsibilities, RPMs possess specific knowledge of investigation activities that produce IDW. USAF RPMs at bases across the United States are required to conduct environmental restoration activities using the IRP (DAF, 1992a:4-1). Consequently, USAF RPMs comprise the population of particular interest to this study.

RPMs are obligated to actively plan, conduct, and document environmental restoration activities in regulator-supervised compliance with environmental laws (US Congress, 1980:Sec 104; DAF, 1992:2-1,2). Consequently, RPMs are likely to possess the sufficient IDW management experience important to this research. For this reason, only environmental restoration managers acknowledged as RPMs comprised the sample from which IDW information was collected.

Population sampling provides an economical alternative to the greater amounts of time, funds, and data required for a population census (Emory, 1991:242). With over three hundred USAF installations across the country (all presumed to be engaged in some level of IRP work), sampling provided a means to conserve resources and keep the quantity of information at a manageable level (DOD, 1992:6). Consequently, only individuals designated as RPMs for bases that had an active IRP were sought to comprise the sample.

Individual RPMs were identified from a list provided by HQ USAF/CEVR at Bolling AFB, Washington, D.C. The list contained one hundred twenty-three individuals who were identified by Air Staff as having RPM duties at one hundred seventy-three USAF bases, sites, plants, and other locations. While the list failed to include all RPMs, it provided sufficient information from which to extract a sample.

The list was initially screened for individuals at bases with DSN voice and telefacsimile capabilities to facilitate communication. To minimize costs and maximize accessibility, RPMs who did not list both telephone and telefacsimile numbers or who used commercial exchanges were eliminated from consideration. The sample selection process was concluded by picking fifteen RPMs. The selections also represented a broad geographic diversity to assure the regulatory influence of several USEPA regions.

Instrument Development and Testing

The instrument selected to collect data for this thesis was the questionnaire. Questionnaires permit data to be collected in an organized yet, relatively economical manner. The questionnaire (APPENDIX A) included a sequence of classification, measurement, and administrative questions.

Classification questions were used to verify that the respondent was an experienced RPM and that the base had an active IRP. Measurement questions gathered quantitative data needed to gage the nature and extent of IDW generation at each base. Data on the number and size of monitor well and sampling bores aided in estimating the quantity of IDW generated at each base. Information about Contaminants of Concern (COC) was requested to ascertain the presence of the pollutants commonly found by IRP investigations. COC information was also used to identify certain substances such as PCB, dioxin, and RCRA hazardous chemicals, which merit special regulation when found on an IRP site.

Measurement questions that required discussion were also used to obtain information. An open-ended question style was used to invite a spontaneous exchange. Beginning questions with phrases such as "What methods are used...?" and "What do you do when...?" allowed respondents to answer in their own words. Grouping discussion questions by topics (IDW characteristics, guidance, contracting, etc.) gave the interviewer some control over the sequence of the interview without stifling the flow of ideas from the respondent.

Administrative questions collected mailing address and telecommunication information to facilitate survey follow-up contacts. This information was also used to verify and supplement the data supplied by the RPM list provided by Air Staff.

The questionnaire used in this study was tested prior to its use. Pretesting is necessary to identify ways the questionnaire could be changed to make it easier for respondents and interviewers to meet the objectives of the research (Fowler, 1984:103). Pre-testing helps to establish: 1) respondent interest, 2) meaning of terms, 3) standard interpretations, 4) continuity and flow, 5) question sequence, and 6) instruction interpretation (Emory, 1991:378). Pretesting of the questionnaire used in this study was conducted at two levels.

The questionnaire was first reviewed by the thesis committee. The feedback from their review caused the questionnaire to be simplified and shortened. Simplification was achieved by eliminating extraneous and redundant questions and reorganizing the sequence in which the remaining questions were asked. Shortening resulted by reducing the requirement for respondents to provide lengthy, written responses (essay-style and enumerated lists) to answer most of the questions. Discussion questions were substituted to accomplish that task.

Later, field testing of the questionnaire was conducted. Field testing was used to verify that the questionnaire was effective in generating useful responses in a reasonable amount of time. RPMs from F.E. Warren, McConnell, and Plattsburgh AFBs were recruited to assist in the field test. Their responses were not included in the survey.

Field testing caused the questionnaire to be revised a second time. Information about IDW volumes and IDW management methods was not consistently included in responses to open-ended discussion questions. Some open-ended discussion questions were eliminated in the final revision when the responses they generated were not useful. Others were replaced by closed-ended questions to prompt more useful responses. Closed-ended questions beginning with phrases such as "How much...?" and "Do you....?" required respondents to supply information that was more easily compared with other bases.

Pretesting, using a two-stage approach, produced a questionnaire that maintained the interest and participation of the respondents while providing the necessary information to support the research objectives of this study.

Data Collection and Preliminary Analysis

In this study, information gathering was conducted with the aid of a data collection plan. Detailed in the following sections, the plan: 1) describes the survey used to gather facts and 2) provides a preliminary analysis of the facts.

Surveying. In order for the study to benefit from individual experiences with IDW management issues, a telephone survey was planned. The survey collected information from the twelve base-level Remedial Project Managers (RPM) identified in the sample selection process.

Before each interview, the questionnaire was transmitted to the RPMs via telefacsimile. In that way, telephone time would be reserved for exchanges centered on the discussion questions. Other than occasional prompting by the interviewer, the respondent carried the discussion.

In order to provide an accurate view of the status of IDW issues at a single point in time, interviewing was conducted over a short period. To maintain objectivity and avoid bias, none of the participants knew who else was contacted nor how many individuals participated in the survey.

Preliminary Analysis. Preliminary analysis provides an opportunity to initiate the discovery process -- an integral part of scientific research (Emory, 1991:476). Preliminary analysis of the data produced by this research involves a two-step process: 1) grouping and 2) validating.

Grouping. Data produced by the telephone interview was collected by note-taking and tape recording. Review of the notes and tapes indicated that oftentimes the responses failed to conform to the desired sequence of responses anticipated. As control was relaxed to encourage respondent spontaneity, responses frequently departed from the planned sequence.

In order to organize the information contained in the responses, a formatted transcription (Appendix B) was developed. Format categories were patterned after the apparent emphasis that respondents placed on certain topics and concepts covered in the interview. The six categories included: 1) site/stages/contaminants, 2) guidance/contract language, 3) methods/quantities/minimization, 4) field screening/initial handling/final disposition, and 5) press/violations/attention. The categories were accepted as natural groupings and represented the initial step of preliminary analysis.

Once the facts were organized into groupings, minor editing was conducted to assure consistency of measurement units, terms, and acronyms.

Validating. Data validation determines if the collected data provides an adequate measurement of the studied phenomenon. The following testing criteria were used to gage the validity of the data.

Sites/Stage/Contaminants. The items in this grouping are aimed at assessing the extent and nature of a base's IRP. A count of sites at each IRP stage and a listing of the contaminants of concern (COC) at the base served as a measure. The site count included the number of sites in each IRP phase such that the sum of all sites equal the total number of IRP sites at a given base. A sum less than the total may mean some sites were unclassified or overlooked. A sum exceeding the total may mean that some sites were counted more than once.

Guidance/Contract Language. Requested as a means to determine the existence of guidance or other printed information that specifically referenced IDW. Each affirmative answer backed with copies of IDW management information (guidance, contract language, etc) provided support that guidance exists. Negative answers indicated that no guidance exists.

Methods/Quantities/Minimization. As a means to assess the potential to generate IDW and to estimate IDW volumes, investigation method and waste quantity information was requested. The mention of any intrusive investigative method and the quantity of IDW produced provided the desired information. Otherwise, information on the depth and diameter of borings was used in conjunction with the number of borings to calculate the volumes of IDW generated. This method may be less valid than total IDW quantity reports because it results from manipulation of design data rather than direct observation. For this reason, the validity of quantities produced by calculations is suspect. Acknowledged efforts to minimize IDW and a description of the methods provided a measurement of the means to achieve minimization as an IDW management option.

Field Screening/Initial Handling/Final Disposition. The items in this grouping were used to answer questions about existing IDW management options. Any mention of observational or instrumental means to characterize IDW at the point of generation qualified as a valid answer. Similarly, any efforts to manage drill cuttings or purged groundwater were categorized as IDW management options.

Press/Violations/Attention. Intended as a means to measure IDW's problem potential, these items include any report of press coverage, documented enforcement (Notice of Violation [NOV], Environmental Compliance and Management Plan [ECAMP] finding, or Inspector General [IG] write-up), or record of public concern provided a valid indicator. Similarly, a negative answer indicated IDW may not pose a problem.

Summary

Surveying was chosen as the method most appropriate to collect data to answer the questions posed by this study. Surveying by telephone interview supported by a questionnaire was used to gather the necessary information.

Interviews were conducted among individuals, known as RPMs, who are responsible for base-level environmental restoration. Identified from an Air Staff list, fifteen RPMs were selected as a representative sample based on accessibility and geographic diversity.

Three RPMs were selected to pre-test the questionnaire prior to its use. Pretesting helped to produce a concise questionnaire that was transmitted to prospective participants.

Twelve RPM interviews, conducted within a four-week period, were noted and recorded. Transcriptions of the interviews provided a convenient opportunity to group data. Minor editing of the interview data assured consistency. Data was validated to determine its usefulness to the study.

IV. Findings and Interpretations

Introduction

This chapter discusses the survey findings. The findings, in combination with the information uncovered by the literature review, were interpreted to answer the research questions. In this way, all the information about IDW regulation, guidance, scope, and handling which was gleaned from the literature review and survey was used to determine the current status of IDW management, as well as to evaluate the need for improvement. This chapter is organized under the following topic headings: 1) application of method, 2) discussion of findings, 3) interpretation of findings, and 4) summary.

Application of Method

The method to collect and manage the information used to answer the questions posed in this study was outlined in chapter three. The following description is an account of that method's application.

Data collection activities were initiated by contacting the twelve RPMs identified in the sample selection process. Each RPM readily agreed to participate in a telephone interview. Because all RPMs were associated with civil engineering squadrons and many squadrons use WANG(R) electronic mail services, a convenient alternative to voice contact was available. The WANG(R) system provided the opportunity for the interviewer to leave electronic mail for RPMs who were difficult to contact.

Questionnaires were transmitted to all RPMs via telefacsimile equipment. Transmittals were from four to ten days ahead of the scheduled telephone interviews. In that way, each respondent had an opportunity to fill out and return the administrative portion of the questionnaire. Advance transmittals also gave participants a chance to review the discussion questions that would be the main topic of the telephone interviews.

Each interview was recorded by hand-written notes and on tape. Permission to tape record responses was requested at the outset of the interview. In no case did a participant decline to continue with an interview upon learning it would be recorded.

Initially, interviews were conducted strictly according to the questionnaire. Subsequently, classification and administrative questions were excluded from the interview to save time. Classification and administrative information was collected by having each respondent fill out the information on the questionnaire form and retransmit it by telefacsimile to the interviewer. Only two RPMs failed to provide the needed information ahead of time.

Responses were initiated by the interviewer posing questions to the participant. Discussion questions were posed in a manner to elicit the desired information while maintaining respondent spontaneity. Allowing respondents to carry the discussions provided an opportunity to learn about the actual circumstances and the practical means used by RPMs to manage IDW.

Work attitudes and communication skills often worked against the interview process. Important but unrelated funding, personnel, and program management topics diverted several respondents from the discussion question topics. Additionally, ill-conceived or inappropriate responses provided by some respondents required clarification. Several respondents were inclined to use product names and abbreviations to account for COCs (e.g., TPH, PD680). While useful to identify contaminant categories, such responses needed clarification to determine actual contaminants (e.g., benzene, toluene, xylene, trichloroethylene, etc.). In several cases, further clarification was not possible due to a lack of detailed information.

In order to provide a reasonable "snapshot" view of IDW issues, interviews were conducted in a relatively short period of time. A short time period reduced the chance that an intervening event (e.g., IDW guidance or policy issuance) would affect response conditions. The interview period for this study was arbitrarily selected at four weeks.

Respondent objectivity was preserved by assuring each participant that confidentiality would be maintained. This assurance was provided by not attributing responses to either individual RPMs or to the bases at which they worked.

Discussion of Findings

At the conclusion of the interview process, a considerable quantity of information had been accumulated. The information was collected to provide answers to the questions posed by this study. The information was organized according to the groupings discussed in chapter three and transcribed on a form (see Appendix B). The following discussion contains a report and analysis of the information found in each grouping.

Sites/Stages/Contaminants. The size of a base IRP may be important to assess the status of IDW management in that it may indicate the potential IDW volumes. IRP size may be measured by the number of sites the base has that are eligible for identification and investigation. Because specimen collection is a significant part of the identification and investigation phases of the IRP, a count of all the sites at PA/SI and RI/FS stages may provide a means to estimate the potential volume of IDW generation.

Figure 8 shows the number of sites under the PA/SI and RI/FS phases at each of the twelve bases surveyed.

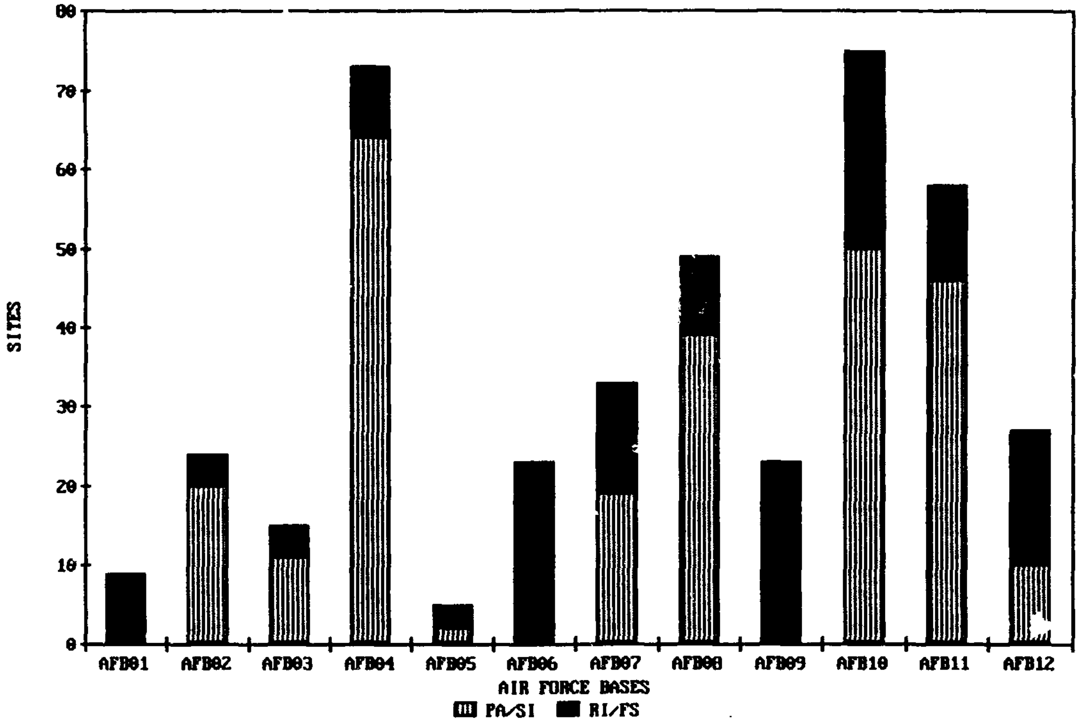


Figure 8. IRP Sites at Twelve USAF Bases

With twelve bases reporting two hundred sixty-one sites at the PA/SI phase and one hundred fifty-three sites at the RI/FS phase, a combined total of four hundred fourteen sites was counted. This count results in an average of approximately thirty five sites per base. In contrast, the average number of sites per installation within the USAF is reported in the FY92 Defense Environmental Restoration Program (DERP) report at approximately thirteen (DOD, 1992:6). This difference is likely due to the fact that the DERP report looks at all USAF installations (including small sites) while this study surveyed major installations only.

Besides the volume of IDW, IDW management is influenced by the type of contaminants likely to be found. The contamination potential of IDW may be associated with the contaminants identified at each base. During the course of the interview each RPM listed the Contaminants of Concern (COC) found at his or her base. Table 3 shows the contaminants and the number of bases reporting them as COCs.

Table 3. Contaminants of Concern at Twelve USAF Bases.

Contaminant of Concern	Bases Reporting As A COC
Benzene, Toluene, Xylene (BTX)	9
Total Petroleum Hydrocarbons (TPH)	7
Metals	6
Cadmium	1
Lead	1
Solvents	3
PD 680	1
Volatile Organic Compounds (VOC)	3
Trichloroethylene (TCE)	3
Vinyl Chloride	2
Chlorinated Hydrocarbons	1
Polychlorinated Biphenyls (PCB)	1
Asbestos	1
Oil and Grease	2
Pesticides	1

The contaminant types and frequencies illustrated in Table 3 were compared with the types and frequencies of the COCs reported by bases scored by the Defense Priority Model in the first half of FY 1993 (table 1). It was found that this survey did not completely correspond to the table 1 results. This may be because several RPMs generalized their reports of contaminants rather than naming specific contaminants (e.g., reporting solvents or metals rather than specifying TCE or lead). Although clarification was attempted to gain more specific contaminant information, the effort did little to improve response accuracy. This was due to a lack of availability to the RPMs of the technical data produced by contract field investigations. Nevertheless, the COC information generated by the survey was accepted for use in this study. The survey information was accepted because it represented the quality of information upon which IDW management decisions are made.

Guidance/Contract Language. In order to establish the existence and sufficiency of IDW guidance, RPMs were asked first, if the term "Investigation-Derived Waste" held any meaning for them and second, if they had received any guidance on IDW management. While only two RPMs recognized the term IDW, all RPMs were familiar with IDW by its description. Not by chance, the two RPMs who recognized IDW terminology came by their knowledge from existing guidance.

Only the two RPMs who were aware of the term IDW had received specific guidance. Four other bases had general IDW information contained in: 1) contaminated construction waste management guidance, 2) LDR/CERCLA-waste periodical articles, 3) and state waste management policy excerpts.

Similarly, contract language related to IDW management was requested from RPMs as a means to identify existing IDW management options. RPMs whose bases used the United States

Army Corps of Engineers (USACE) as a service center were able to provide IDW contract language. USACE remedial contracts demonstrated that an effort to manage IDW was being implemented through use of the following contract language:

> Disposal of Investigation-Derived Wastes (IDW). The A-E shall carefully mark each drum with the soils/water location so that sample results from the required analysis can be used to identify which materials may be hazardous. Drums shall be stored at a location approved by the Base Environmental Coordinator (BEC) pending analytical results. The non-hazardous soils shall be disposed of on Base per direction of the Base BEC and the non-hazardous waters shall be disposed of by pumping to the nearest manhole leading to the POTW with approval from the Base. This shall be accomplished prior to the demobilization of the A-E from the job site. The drums shall be steam-cleaned and returned to the Base for their use. (USACE, 1993:Sec 10.7)

While useful in terms of handling non-hazardous IDW, the USACE contract language provides little guidance in the management of hazardous IDW other than requiring it to be containerized.

Methods/Quantities/Minimization. IRP investigation methods were also discussed in order to estimate the potential volume of IDW. Because some methods have a greater potential to generate IDW than others, knowledge of current investigation methods may enable forecasting of future IDW volumes.

It was found that the method most frequently used to collect specimens was auger boring. All twelve RPMs indicated a preference for this method as a means to produce specimens for chemical analysis. Five bases also used hydraulic drilling and two bases used surface specimen collection to obtain chemical data.

IDW volume was also determined using quantity data and borehole design information. RPMs supplied a variety of IDW quantity data including: 1) container volumes, and 2) borehole counts and dimensions.

The widespread use of 55-gallon drums to containerize IDW at sites provided a convenient unit of measurement. However, quantity estimates derived from these measurements would be highly variable due to the lack of information about the drum's actual contents.

All RPMs reported the use of drums. The twelve bases had a total of one thousand five hundred seventeen drums on site at the time of the interview. Ranging from 15 to 500 drums per base, each base averaged one hundred and twenty six drums on hand. Figure 9 shows the accumulation of IDW-laden drums at each base.

In order to determine if the size of a base IRP correlated to the number of drums retained, a comparison was made by looking at figures 8 and 9. Correlation was found to be poor. Retained IDW at bases with relatively large IRPs (greater than seventy sites) ranged from zero (AFB04) to over nine hundred (AFB10). Even at bases with small IRPs (other than at AFB02, AFB03, and AFB05), little correlation appeared to exist between the size of the base IRP and the amount of IDW retained.

Because auger boring was mentioned as the preferred method of specimen collection, auger boring dimensions and counts were discussed during the interview. Knowledge of borehole designs and the number of boreholes

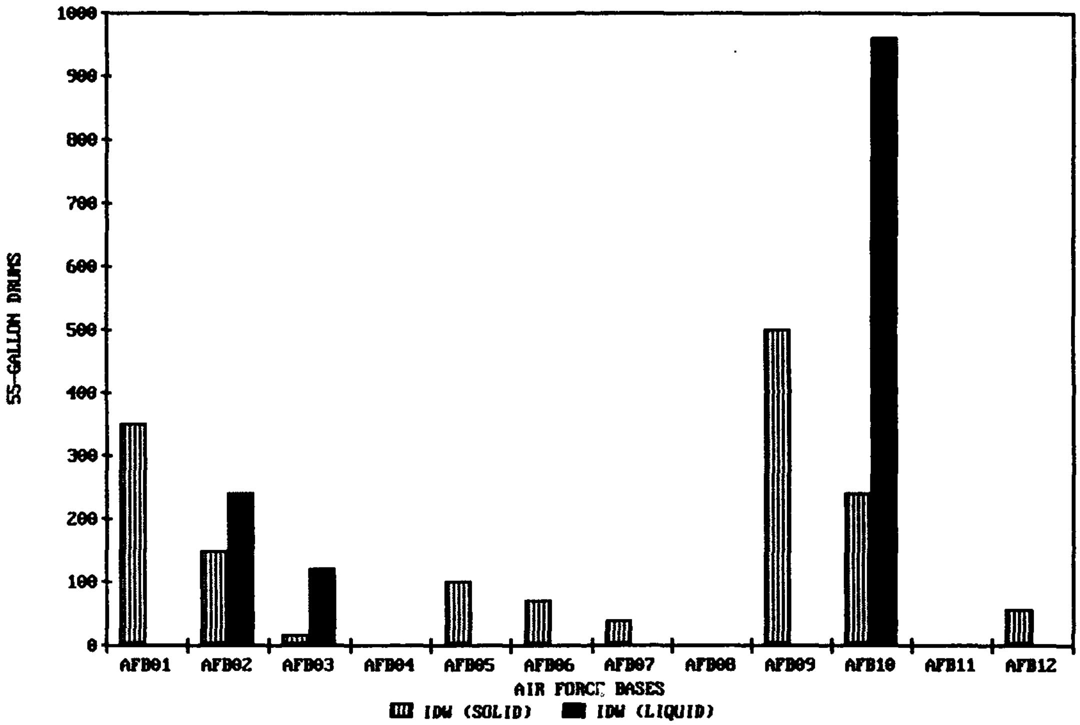


Figure 9. Containerized IDW Retained at Twelve USAF Bases

may provide an alternative means to determine the extent of IDW. Calculations based upon borehole dimensions and water table levels may allow estimates of solid and liquid IDW to be made in the absence of an inventory of drums. For this reason, RPMs were asked to report borehole design data and borehole counts. Unfortunately, citing the widespread use of service center contractors, many RPMs lacked this information.

However, some respondents reported borehole diameters ranging between two and eight inches. Depths of boreholes and monitor wells ranged between ten and three hundred fifty feet. Calculations using this data indicate that the production of solid IDW from auger boring may range from two-tenths to one hundred twenty cubic feet per borehole. Similarly, calculations using borehole diameters and standing water depths may yield estimates of liquid IDW. It was found that only two RPMs had the needed information for this calculation. Consequently, calculation of liquid IDW volumes was deferred for lack of data.

The degree to which RPMs had implemented minimization options was discussed. Four RPMs indicated that they had at least considered minimization as an IDW management option. Three RPMs endorsed the use of cone penetrometers as an alternative to auger boring to collect water samples. Cone penetrometers were described as a type of sampling tool which is driven, rather than drilled, below the ground surface. Their use permits groundwater specimens to be collected at depths of thirty feet or more without producing significant amounts of IDW.

In addition to alternative specimen collection methods, one RPM advocated better specimen collection planning to minimize the amount of IDW generated. However, no one actually practiced IDW minimization.

Field Screening/Initial Handling/Final Disposition. Information to answer questions about current IDW management practice was gathered during discussions about field screening, initial handling, and the final disposition of IDW.

Field screening represents an important first-step in IDW management. It involves the actions by site personnel to characterize IDW when it first is gathered. Although field screening provided an early opportunity to gather information vital to worker safety and regulatory compliance, this study found that RPM preferences for methods varied widely. Table 4 shows the range of field screening methods preferred and the degree to which they are applied at each of the twelve bases contacted.

While it was found that three bases used no field screening, nine bases used several observational and instrumental field screening techniques. Observations by site personnel using no more than their eyes and noses to detect contamination was reported in use at two bases. At the remaining seven bases, instruments such as: 1) flame-ionizing detectors (FID), which detects the presence of a vapor or a gas by measuring a change in conductivity resulting from exposure to a standard flame (usually hydrogen); 2) photo-ionizing detectors (PID), which detects

Table 4. Field Screening Preferences at Twelve USAF Bases.

BASE	GC	FID	PID	HNU	Sight/Smell
	SCREENING METHOD				
AFB01	-	-	-	X	-
AFB02	X	X	X	X	X
AFB03	-	-	-	-	-
AFB04	-	-	-	-	X
ABF05	X	-	-	-	X
AFB06	-	-	-	-	-
AFB07	-	X	X	X	-
AFB08	X	-	-	-	-
AFB09	-	-	-	-	X
AFB10	-	-	-	X	-
AFB11	-	-	X	X	-
AFB12	-	-	-	-	-

the presence of a gas or vapor by measuring a change in conductivity resulting from exposure to visible light; and 3) gas chromatographs (GC), which detect the presence of volatile compounds by measuring the gas component separated by absorption from a moving phase were used as instrumental field screening methods. Several RPMs also reported the use of instruments called HNU. HNU is a brand name for a popular type of PID.

Citing the use of contract technicians as the reason, several RPMs admitted to having little information about actual field screening methods and procedures. Lack of information also prevented many RPMs from knowing the extent to which field screening was applied and for what contaminants it was best suited to detect.

One base provided the following contract language to ensure adequate field screening of soils was accomplished by the contractor's personnel:

> Jar Headspace Method of Soil Screening
>
> The headspace method will require that soils be containerized at each 2.5 ft depth. The samples selected by the headspace screen will be shipped to the A-E and Missouri River Division (MRD) Laboratories and the other soil will be discarded with the drill cuttings. The following methodology is verbatim from Table 7 of the "Interim Site Investigation Protocol Document", prepared by the MA-DEP dated 9 April 1991 as Policy WSC 401-91.
>
> 1. Half-fill one or two 8-16 oz clean glass jars with the sample to be analyzed. Cover with a clean sheet of aluminum, and apply the screw cap to seal tightly.
>
> 2. Allow headspace development for at least 10 minutes. Vigorously shake jars for 15 seconds both at the beginning and end of the headspace development period. If ambient temperature is below 32 F, develop headspace in a heated vehicle or building.
>
> 3. Subsequent to headspace development, remove screw lid/expose foil seal. Quickly puncture foil seal with instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulate.
>
> 4. Record highest meter reading, which should occur 2-5 seconds following probe insertion. Erratic readings may occur at elevated humidity or at high organic vapor concentrations. Screening data from duplicate jars should be consistent within + or - 20 percent.

5. PID and FID field instruments will be operated and calibrated to yield "total organic vapors" in ppm (v/v). PID instruments must be operated with a 10.0 eV (+/-) lamp source. Operation, maintenance, and calibration shall be performed in accordance with the manufacturer's specifications. For jar headspace analysis, instrument calibration shall be checked/adjusted no less than once every 10 analyses, or daily, which ever is greater.

If more than one split-spoon sample exhibits an HNU reading of > 50 ppm, the USACE field representative, if present or the project chemist, will be notified to discuss possible changes to the project scope (USACE, 1993:Sec 5.3.2.2.).

No such language was found to address field screening of liquid IDW.

Initial handling may be any action the RPM elects to immediately control IDW at the point of generation. Table 5 shows the initial handling preferences at each of the twelve bases contacted.

Initial handling consists of short-term solutions to control IDW until final disposition decisions may be implemented. Initial handling may include replacement, stockpiling, or containerization.

Eleven bases were found to containerize IDW. Of those electing to immediately containerize IDW, two bases conducted composite sampling. One base relied on piling solid IDW on plastic sheeting. Two RPMs used tanks to hold liquid IDW. One RPM released liquid IDW at the site.

Ideally, initial handling decisions should reflect the degree of risk that IDW poses. Risk, as a function of IDW characteristics, may be determined by the information revealed by field screening. In order to determine if field screening was used to help make initial handling decisions, a comparison was made between tables 4 and 5.

The comparison indicated little correlation between the use of field screening and initial handling decisions. IDW was drummed, except at AFB09, regardless of the degree of screening used. At several bases (e.g., AFB03, AFB06, and AFB12) where no screening was done, containerization was as popular an initial handling method as at other bases (e.g., AFB02, AFB07, and AFB11) where several screening methods were employed.

Final disposition describes what ultimately happens to IDW. Table 6 shows the final disposition preferences at each of the twelve bases contacted. Ideally, final disposition is the action taken by the RPM to reduce or eliminate the risk of IDW to humans and the environment. A variety of treatment, storage and disposal options were reported by RPMs.

The most popular option, disposal, was reportedly used at all twelve bases to some degree. Depending on the type and level of contamination, disposal consisted of either redistribution of IDW at the site or removal to a landfill. On-site disposal of non-hazardous IDW at several bases was guided by USACE remedial action contract language. Off-site disposal of IDW was handled by separate contracts. Two bases relied on the services of DRMO to handle IDW disposal.

Table 5. Initial Handling Preferences at Twelve USAF Bases.

BASE	INITIAL HANDLING PILE	DRUM	TANK	COMMENT
AFB01	X	X	-	Segregated by screening
AFB02	-	X	X	Drum solid/tank liquid
AFB03	-	X	X	Drum solid/tank liquid
AFB04	-	X	-	Drums are sampled
ABF05	-	X	-	Drum solid/Dump liquid
AFB06	X	X	-	Pile solid/Drum liquid
AFB07	-	X	-	Drums labelled/dated
AFB08	-	X	-	All IDW drummed
AFB09	X	-	-	Pile solid
AFB10	-	X	-	Drums are sampled
AFB11	-	X	-	Drum JP-4/Roll-off Bin solid
AFB12	-	X	-	All IDW drummed

Treatment, as a final disposition option, was used by five RPMs. Treatment was used when oil/water separators or wastewater treatment plants (WWTP), both USAF and publicly owned, provided a convenient opportunity to handle non-hazardous liquid IDW.

Storage was selected by only one RPM. Storage was used as a means to defer final disposition of contaminated IDW until it could be incorporated into the final remedy for the site.

Table 6. Final Disposition Preferences at Twelve USAF Bases.

BASE	FINAL DISPOSITION TREAT	STORE	DISPOSE	ACTION/ACTOR
AFB01	X	X	X	Site/Storm Sewer
AFB02	X	-	X	Landfill/Site/O&W Separator
AFB03	X	-	X	Landfill/Sanitary Sewer/DRMO
AFB04	X	-	X	Landfill/POTW
ABF05	-	-	X	Landfill/Site
AFB06	X	-	X	Landfill/Sewer
AFB07	-	-	X	Disposal Contractor
AFB08	-	-	X	Disposal Contractor
AFB09	X	-	X	Landfill/Site/Base WWTP
AFB10	X	-	X	Disposal Contractor/POTW
AFB11	-	-	X	Landfill
AFB12	-	-	X	Site/DRMO

In order to determine if a correlation between initial handling and final disposition existed, a comparison was made between tables 5 and 6. At several bases (AFB05, AFB07, AFB08, AFB11, and AFB12) where all IDW was drummed, disposal was used exclusively. Other bases used a more selective approach. At AFB01, AFB02, AFB03, and AFB06, several final disposition methods were used. In general, it was found that bases that tended to limit their use of initial handling options tended to be limited in their final disposition options. On the other hand, bases that exercised more variety in their initial handling decisions had several final disposition options from which to choose.

In addition, a comparison of the amount of IDW retained by each of the two groups (limited handling options vs multiple handling options) was made. It was found that the bases (AFB05, AFB07, AFB08, AFB11, and AFB12) that exclusively drummed and disposed of their IDW, on average, had less IDW on hand (39 drums) than those bases (AFB01, AFB03, and AFB06) who adopted a more varied approach (146 drums).

Press/Violations/Attention. Finally, the problems associated with IDW were discussed. This information may be used to determine the impact of IDW management with respect to the regulators and the public. The discussion questions were framed to measure the RPMs perception of negative feedback about IDW. In this way, reports of bad press, NOV issuance, or public concern may provide a measurement of observer impressions.

Of the nine bases reporting IDW-related feedback, seven stated that IDW brought unwanted attention. Four mentioned base commander and inspector (e.g., ECAMP, IG, etc.) concerns about prolonged storage of IDW. At least three RPMs mentioned unwanted regulator attention as a consequence of IDW retention. One base reported "almost" getting an NOV for an undisclosed but IDW-related noncompliance situation.

Two bases indicated that they had no IDW-related feedback problems.

Feedback was most often found to occur as a result of IDW accumulation. IDW may accumulate for several reasons including: closely held IDW reduces exposure risk, insufficiently characterized IDW requires protective isolation, and inappropriately containerized IDW defies simple removal. The following comparisons were made to determine any correlations between the reasons that IDW accumulates and the feedback that results.

Figure 9 shows the amount of IDW retained at each base at the time of the interview. Three bases (AFB04, AFB08, and AFB11) reported no IDW on site. Of the three bases, one base (AFB08) reported no IDW-related feedback, another base (AFB04) reported "almost" getting an NOV for an IDW-related issue, and yet another base (AFB11) reported unwanted regulator attention stemming from IDW disposal. Another base (AFB12) that reported no feedback was found to have retained only a small amount of IDW. Otherwise, the bases which complained of multiple or repeated instances of inspector and regulator contacts were found to retain the bulk of the IDW found in this study. For these reasons a correlation between the amount of IDW retained and the degree of feedback is believed to exist.

Table 4 indicates the method(s) used by each base to field screen IDW at a site. Three bases (AFB03, AFB06, and

AFB12) reported no field screening preferences. Of the three, two bases (AFB03 and AFB12) reported no IDW-related feedback but the other base received significant unwanted attention from ECAMP and IG inspectors. Of the bases that used several field screening methods (AFB02, AFB05, AFB07, and AFB11), all but one reported unwanted program intervention and inspector or regulator attention related to IDW issues.

Table 5 reveals the initial handling preferences used to control IDW at each of the twelve bases contacted. Eight bases (AFB04, AFB05, AFB07, AFB08, AFB09, AFB10, AFB11, and AFB12) indicated a single initial handling preferences. Two of the seven included the bases (AFB08 and AFB12) that reported no IDW-related feedback. The remaining four bases used multiple preferences yet all incurred IDW-related feedback. Consequently, no correlation between the degree of initial handling and the degree of feedback exists.

Interpretation of Findings

The facts uncovered by the literature review and the interviews are discussed and analyzed to answer the research questions. The following discussion is organized according to the sequence of the research questions posed in chapter one.

RESEARCH QUESTION #1

QUESTION. What is the extent and nature of IDW generated by IRP investigations?

FINDING. From the literature review it was found that the potential extent of IDW depends upon the scope of the IRP and the methods used to conduct the investigations associated with it. Data on the number of sites were gathered to assess the potential scope of the IRP. RPMs reported a total of four hundred fourteen sites at SI and RI stages at the twelve bases contacted. This indicates that an average of approximately thirty five sites per base have undergone the identification and investigation phases of the IRP.

The preference stated by the twelve RPMs for intrusive specimen collection methods to characterize IRP sites indicates a significant potential for IDW generation. All twelve bases reported the use of some type of intrusive specimen collection method (e.g., drilling, boring). Several bases supplied monitor well and bore hole design information to permit volume calculations in the absence of IDW quantity information. The calculations may only be used to estimate the initial extent of IDW, however. Additional information is needed to determine the total extent of IDW at any site. This is due to the likelihood that subsequent collections (especially those involving groundwater specimens) may produce IDW far in excess of initial volumes.

Using values calculated from information collected in this study, the number of sites (414 sites), borehole dimensions (average monitor well depths of 25 feet and average diameters of 6 inches), and seven borings per site, the initial extent of IDW generated at twelve bases is estimated at two thousand five hundred eighty-six drums. At an average of over six drums per site, the initial extent of IDW to be generated at the remaining one thousand eight hundred sixty-four USAF sites exceeds eleven thousand drums (DOD, 1992:7). It is important to note that the IDW estimated by these calculations and retained by the RPMs is that which is initially generated during borehole construction. While mainly consisting of solid material, it was found that initial IDW may be drummed with varying proportions of liquids and indigenous material as well.

<u>FINDING</u>. This study found that the number of drums (1517 drums) retained on all twelve bases was less than the potential number of drums (2586 drums) estimated by calculation. Considering that more IDW may be forthcoming, that some IDW may have been removed, and that some IDW was not containerized, the amount of IDW found to be on hand seems reasonable.

Due to insufficient data, separate estimates of liquid IDW generation and retention values were not made. While significant amounts of liquid IDW may result from subsequent groundwater specimen collection events, the nature of such events are too variable to project quantity estimates. Consequently, the lack of information to explain the circumstances leading to the retention of the relatively large amount (65,000 gallons) of liquid IDW at three bases (AFB02, AFB03, and AFB10) prevented generalization of this finding to other sites in this study.

FINDING. Contaminants of Concern (COC) helped to establish the potential nature of IDW. The contaminants reported in table 3 represent the characteristics of the IDW at the twelve USAF bases contacted in this study. The information indicates that the contaminants that concern RPMs most often are benzene, toluene, xylene, solvents and metals. While high quality information was not readily available, it is likely that the COCs found in this study are similar to those found during other characterizations of the IRP.

RESEARCH QUESTION #2

QUESTION. Which federal environmental laws and DOD/USAF regulations apply to IDW?

FINDING. The literature review disclosed the information needed to answer this question. USEPA guidance indicated that the laws that apply to IDW are those which apply to the management of solid and hazardous waste. While the hazardous waste laws -- RCRA and CERCLA, regulate the designation, transportation and disposition of waste materials, it is necessary to consider the influence of "media" laws, especially the CWA, when selecting off-site IDW management options. Otherwise, the requirements of the Hazardous Materials Transportation Act (HMTA) and state laws must be observed.

RESEARCH QUESTION #3

QUESTION. How are base-level IRP managers currently managing IDW?

FINDING. This study found that IDW management is addressed in the course of IRP site investigations. The degree to which IDW is managed largely depends upon the attitudes of the RPM at the base where it is generated. In general, base-level RPMs use a step-wise process to manage IDW. The process is aimed at identifying, controlling, and isolating wastes produced at IRP sites as a means to prevent the spread of contamination and to avoid unwanted attention from environmental regulators and base commanders.

During the interviews, RPMs were asked to describe the procedures they used to deal with IDW. Analysis of the interview information revealed a three-step IDW management procedure -- field screening, initial handling, and final disposition. The procedure, developed independently by base-level FPMs, addresses IDW handling without consideration of minimization. Each step of the process discovered by this study is more fully described in the following sections. The discussion of minimization is left to later sections.

Field screening is the action taken to detect contamination during boring operations and specimen collection. Field screening may be accomplished by observational or instrumental methods. In instances when the environmental media is grossly contaminated, the appearance or odor of specimens was found by several RPMs to be an adequate means to identify specific contaminants. This study found that two RPMs routinely use observational methods to identify BTX and Total Petroleum Hydrocarbons (TPH) in IDW at the point of generation. According to USEPA guidance, observational methods are adequate to characterize IDW when detection of contaminants is required (USEPA, 1991:13).

Otherwise, contaminant identification was accomplished through more sophisticated instrumental means. In trained and experienced hands, portable flame-ionizing detectors (FID), photo-ionizing detectors (PID) and gas chromatographs (GC) allowed contaminants to be identified in the field. Normally, used as a means to monitor site safety conditions and to indicate contact with the zone of contamination, instrumental field screening methods may be used to characterize IDW.

Nine of the twelve base reported using field screening methods. Six RPMs stated that field screening at their bases included instrumental methods while three relied upon observational methods. However, three bases (AFB03, AFB06, and AFB12) were found to use no field screening. Total lack of knowledge about IDW characteristics is unwise because site workers are deprived of critical knowledge that they need to protect themselves and it may lead to violations of regulations during handling and disposal (USEPA, 1991:13).

Discussions revealed that RPMs preferred a wide range of methods. Little information was disclosed about what influenced the choice of methods other than at one base (AFB07) where field screening was found to be guided by contract language. Lacking additional information, it is not possible to establish a pattern to the method selection process used by the RPMs contacted in this study.

The relatively wide-spread use of field screening methods indicated that RPMs have the means to determine if IDW posed risks or incurred regulation. However, there appeared to be a tendency for RPMs to be conservative in their handling of IDW regardless of the method used, if any, to characterize it. Applied consistently and purposefully, the field screening methods may be used to support protection and compliance decisions necessary in the next step of the procedure -- initial handling.

Initial handling is the action taken to control IDW at the site. The degree of control required depends upon IDW characteristics and consequences of exposure to it. Ideally, initial handling decisions are based upon knowledge developed through the use of field screening information and are in accordance with site remediation plans. Actually, initial handling decisions were found to be influenced by RPM attitudes. Initial handling decisions made by RPMs contacted in this study revealed an attitude toward tight IDW control.

RPMs reported a preference for controlling IDW by containerizing it. Eleven of twelve RPMs stated that IDW produced at their bases was placed in drums. To a lesser degree IDW was routinely handled by piling it on the ground over plastic (AFB09) and placing it in roll-off bins (AFB11). Several base reported spreading uncontaminated IDW around the site. Liquid IDW was drummed, placed in tanks (AFB02 and AFB03), or dumped on the ground at the site.

The initial handling methods described above have resulted in the accumulation and virtual abandonment of over fifteen hundred drums and sixty-five thousand gallons of IDW at the twelve bases contacted. In terms of IDW guidance: "USEPA prefers to leave both RCRA hazardous and non-hazardous IDW on site whenever it complies with regulations and does not pose any immediate threat to human health and the environment" (USEPA, 1991:19). Doubtless, containerized IDW poses little danger of exposure. However, in view of the discussion related to field screening, it is difficult to determine if the degree of IDW contamination merited the level of protection that containerization affords. Also, there is little evidence that the drums left at the sites are awaiting final disposition through implementation of the final remedy.

Final disposition is the last step of IDW management. Final disposition is the action taken to determine the ultimate fate of IDW. Final disposition was interpreted by the vast majority of RPMs to mean disposal. Those who mentioned treatment did so only in reference to liquid IDW. Storage was mentioned only once and, then, only as an interim method.

Storage, as an interim IDW management method, is endorsed by USEPA. Storage of hazardous IDW is especially favored by IDW guidance and RCRA regulations as an interim measure for sites destined for clean up. Where clean-up activities are implemented, stored hazardous IDW at the site may be incorporated in the final site remedy (USEPA: 1992:5). Storage, for just such a purpose, was used at one base.

Storage was mentioned at one other base, as well. Unfortunately, a description of the circumstances revealed that suspected hazardous IDW had been relocated to an unsecured holding area for an indefinite period of time. According to RCRA, such an action may be construed as land disposal for which a permit is required. Additionally, it is highly likely that hazardous IDW stored in such a fashion may inappropriately pose a significant exposure risk.

Treatment of IDW was reported at six of the twelve bases. Treatment of IDW is limited to the simple physical and biological methods currently used for industrial and domestic wastewater. Liquid IDW from well completion, specimen collection, and equipment decontamination activities is released to nearby oil/water separators and sanitary sewers. At the oil/water separators, liquid IDW containing fuel, oil, and other petroleum products is poured into a chamber where it is allowed to stratify. IDW contaminants are disposed with the accumulated sludge and the lighter-than-water material skimmed from the surface in the separator. The aqueous portion of the liquid IDW is then released to the sanitary sewer. IDW that is released to the sanitary sewer is likely treated by an on-base wastewater treatment plants (WWTP) or a nearby POTW.

One base reported releasing liquid IDW to a stormwater sewer. Stormwater sewers typically intercept precipitation runoff and direct it, without treatment, to surface water impoundments or channels. Consequently, liquid IDW handled in such a fashion may cause the uncontrolled release of contamination. As stated in the IDW guidance, releases of contaminated liquids to surface waters and off-site POTWs are subject to both the administrative and substantive requirements of CWA (USEPA: 1992:4). RPMs releasing IDW to stormwater sewers are likely in violation of several ARARs.

Disposal offers an expedient means to achieve final disposition of IDW. According to USEPA guidance, disposal is appropriate when the potential for risk from exposure is high or when there is elevated public concern. Disposal of IDW usually involves relocation and placement of IDW at an off-site facility. Disposal of hazardous IDW at an off-site facility normally requires full compliance with several ARARs. Nevertheless, disposal was the most popular means of final disposition; it was used, in some degree, by all twelve of the RPMs interviewed for this study.

IDW disposal methods ranged from simple distribution of IDW by field personnel at the site to collection, transportation and deposition of IDW by a hazardous waste contractor in a RCRA Subtitle C facility. When IDW is characterized as RCRA hazardous waste, guidance indicates that disposal at an off-site facility requires generators to comply with CERCLA Off-site policy and RCRA requirements.

Otherwise, disposal of non-hazardous IDW is a relatively simple matter when it is handled locally as several RPMs did. Upon receipt of specimen chemical analysis, RPMs returned the IDW generated by the specimen collection activity to the borings or reused it to grade the site. Subject to avoiding the appearance of land disposal and verifying that the retained IDW is non-hazardous, on-site disposal may be the swiftest and most economical means of final disposition that meets protection and compliance requirements.

QUESTION. Has adequate guidance been provided?

FINDING. No. In terms of the content and availability of the material discovered by this study, IDW management guidance is inadequate.

Guidance dedicated to IDW management was located by the literature review. Guidance appeared in two forms: 1) published documents 2) excerpted text. Only two specific IDW guidance documents were identified in the course of this study: 1) Management of Investigation-Derived Waste During Site Inspections and 2) Guide to Management of Investigation-Derived Wastes (USEPA, 1991; 1992). Both were published by the USEPA. They present the general concepts of IDW management and few options to implement it. Non-specific guidance relating to IDW was provided by several RPMs. Printed material excerpted from three contracts and two state environmental regulator policy documents provided guidance for: 1) non-hazardous IDW accumulation and handling, 2) contaminated construction debris management and 3) drill cutting disposal at hazardous waste sites. While helpful in suggesting methods to handle some types of wastes, the excerpted material did not address the full range of IDW type and characteristic combinations likely to occur at an IRP site. For example, the contract language issued by the USACE Omaha office and used in IRP projects at several bases, considered only non-hazardous IDW management.

QUESTION. Are current management methods meeting IDW regulatory guidelines?

FINDING. No. Current methods fail to adhere to USEPA IDW management guidelines in several aspects, the most significant of which is the finding that three bases (AFB03, AFB06, and AFB12) conduct no field screening. As stated in USEPA guidance, failure to characterize IDW jeopardizes worker safety and risks regulator enforcement.

In general, guidelines suggest that the appropriate first step to IDW management is minimization. This study found that only one base (AFB10) had considered better specimen collection planning as a means to avoid IDW generation and only a few bases (AFB02, AFB05, and AFB08) had considered alternative specimen collection methods to reduce IDW generation. No bases were found to practice minimization.

Otherwise, guidance suggests that the IDW which must be generated should be retained for incorporation to the final remedy for the site. In this way, the effort and expense to ultimately clean up a site may be applied to the IDW as well. This study found that only one base (AFB01) adopted this approach.

USEPA guidance also requires that IDW be managed in a manner that protects human health and the environment as well as complies with environmental laws. Because the IDW at the bases in this study often contained hazardous substances, the potential for harm from exposure to humans and the environment exists. This study found that a high level of protection from exposure to IDW exists due to a strong preference of RPMs to promptly containerize it. Isolated by steel drum walls and plastic tank liners from workers and the site, IDW is unlikely to pose any immediate risk.

In terms of compliance, current IDW management methods may be insufficient. This study found that RPMs use several treatment, storage, and disposal options to manage IDW. With disposal being the most popular, it was found that many RPMs delegated compliance duties (labelling, manifesting, transporting, and etc.) to private contractors or DRMO. Treatment of IDW was found to be less formal. Several RPMs elected to use local oil/water separators and sewers as a method to handle liquid IDW. However, during interview discussions it was found that few RPMs were aware that releases of wastes to surface waters and POTWs may be eligible for regulation under the CWA. This circumstance is especially critical at one base (AFB01) where liquid IDW is disposed of in the storm sewer. Because most storm sewers drain directly to surface waters and come under the provisions of the CWA, it is possible that this IDW disposal method is in violation of regulations.

The one base (AFB01) found in this study that elected to use storage did so for the purpose of retaining IDW on site for ultimate incorporation in the final remedy. Because IDW was stored for that purpose alone, compliance with the laws that regulate IDW was deferred. IDW that is retained without planning for incorporation in the final remedy is likely subject to regulation under RCRA.

It was found that bases with relatively large accumulations of IDW were more prone to negative feedback from commanders and unwanted attention from environmental regulators. Although the one base (AFB04) that admitted to "almost" getting an NOV reported no IDW on base, other bases that had retained IDW complained of IG, ECAMP, and regulator concerns about seemingly abandoned waste containers. Bases where IDW management methods more closely complied with USEPA IDW guidance were found to have fewer complaints.

RESEARCH QUESTION #4

QUESTION. What solid waste and hazardous waste management options, including minimization, can be applied to IDW.

FINDING.

Minimization Management Options. Minimization is a hazardous waste management option that reduces the amount of waste to be managed by reducing the amount of waste that is generated. Minimization may be achieved by process modification, material substitution, or reuse/reclamation. According to USEPA guidance, minimization is the primary objective of IDW management (USEPA, 1992:5). Applied to IDW management, minimization serves to reduce or eliminate the volume of IDW by avoiding its generation.

The opportunity to employ minimization as an IDW management option first occurs in the field-work planning stages of the IRP. Work plan documents that prescribe monitoring well and borehole designs and locations are developed early in the IRP to guide the investigation activities necessary to characterize the site. Site characterization depends upon vast amounts of soil and groundwater chemical data which is produced by the analysis of specimens. Specimens of environmental media extracted from the earth by intrusive physical methods are a significant source of IDW. Because material substitution does not apply (there may be no acceptable substitute for physical data to characterize a site) and the amount of IDW that may be reused or reclaimed is likely insignificant, the impact of IDW minimization may be best realized through process modification.

The investigation planning process may permit significant reductions in IDW. As stated above, the purpose of investigation is to produce data. However, data may already be available. Data from project records, files, contracts, post-construction drawings, and photographs may provide clues about the extent of the contamination, results of previous investigations, or hitherto unknown circumstances that may simplify investigations and reduce the need to conduct IDW-producing specimen collections. This position was supported by at least one of the RPMs at a base (AFB10) contacted in this study who stated that better investigation planning may help reduce the amount of IDW generated during the IRP.

Minimization of IDW may also be realized by modifying the investigation process itself. Adoption of alternate specimen collection methods used in the investigation process may reduce the amount of IDW generated. Alternate investigation methods were tried by RPMs at three bases (AFB02, AFB05, and AFB08) who reported using cone penetrometers instead of monitor wells to collect groundwater specimens.

Solid Waste Management Options. IDW that is shown to be non-hazardous or exempted from hazardous waste regulations may be managed as a solid waste (DAF, 1992b:Sec 4, 4). Classification of non-hazardous IDW requires verification that contamination does not exist or exists at concentration levels below that which are considered dangerous for each contaminant species. Subject to proper characterization, non-hazardous IDW may be discarded as solid waste according to USEPA guidance. USEPA guidance provides several on-site options to manage IDW as a solid waste. Non-hazardous IDW soil may be: 1) placed back into the borings, 2) spread around the site, or 3) put into a pit and covered with surface soils.

Because liquids may be included in the solid waste definition of "any" discarded material, non-hazardous liquid IDW may be managed as solid waste (Arbuckle and others, 1991:410). USEPA guidance suggests several solid waste management options for liquid IDW. On-site options for RCRA non-hazardous decontamination fluids and groundwater include: 1) pouring on the ground, 2) discharging it next to well, and 3) removing it to an existing TDU.

On-site, non-hazardous solid waste management options were popular among several RPMs as a means to manage IDW. Several RPMs indicated a preference for dumping solid IDW back in the boring or in the vicinity from which it was produced. The use of solid non-hazardous IDW for backfilling or site grading may also qualify as an application of the minimization option because it allows accumulated IDW to be reused for site reclamation.

Off-site solid waste management options involved several intermediate steps before the waste may be transported to its final resting place. IDW comprised of decontamination fluids, groundwater, and soil must first be containerized and tested. Upon determination that it is non-hazardous, IDW may be transported to: 1) a RCRA Subtitle D facility, 2) a POTW, or 3) other facility depending upon its type (solid, liquid, indigenous). This option was extremely popular in that all bases adopted it to some degree.

Off-site management of non-hazardous PPE and DE is nearly as convenient. Intended to be disposed as solid waste, decontaminated PPE and DE may be double bagged and drummed prior to being relocated to: 1) a municipal landfill or 2) a local or USEPA dumpster (USEPA, 1991:23,24).

Hazardous Waste Management Options. Solid waste that contains hazardous substances may be characterized as hazardous waste. Hazardous waste management options apply to IDW characterized as hazardous. Several hazardous waste management options may be found in USEPA and USAF guidance. Each suggests several methods that may be used for on site or off site situations.

On-site management of hazardous IDW has several advantages. First, the risk of exposure to IDW confined at an IRP site is far less than when it is moved to an off-site location. Second, IDW that is not moved from the site at which it was generated avoids potentially complex compliance issues. Last, hazardous IDW that is retained on site for the purpose of incorporation in the final remedy meets a main objective of IDW management as stated in USEPA guidance.

The options available to manage hazardous IDW on site are similar to those used for solid waste. They include:

1) putting IDW back into the boring, 2) putting IDW in a pit and covering it with surface soils, and 3) putting IDW in a TDU. The difference between the use of these options for hazardous IDW and for non-hazardous IDW is that hazardous IDW is stored temporarily where non-hazardous waste may be placed permanently. Hazardous waste permanently placed would normally incur strict RCRA (and possibly LDR) compliance requirements. Hazardous IDW awaiting the implementation of the final remedy for the site may be exempted from compliance until such time that final remedy is implemented (Wentz, 1989:80). Then, when implementation occurs, compliance may be comprehensively addressed.

Otherwise, hazardous IDW may be managed with the use of off-site options. As with non-hazardous IDW, that which is intended for export must be containerized, tested, transported, and delivered to a proper facility (USEPA, 1991:24). While some off-site hazardous waste management options were independently developed by RPMs to meet individual circumstances, two individuals used an existing USAF hazardous waste management option to cope with IDW.

The option involves local turn-in of IDW to the Defense Reutilization and Marketing Office (DRMO)(DAF, 1992b:Sec 2, 2; Sec 6, 1). Since waste disposal and recycling contracting responsibilities were assigned by DOD to the Defense Logistics Agency (DLA) in 1990, DRMO has handled hazardous waste at USAF bases with disposal contracts (GAO, 1991:11; Wassom, 1991:6-8). DRMO contracts are designed to dispose of relatively small increments of segregated hazardous waste material at unit prices based upon weights (Babos, 1991:61). This option is widely used by supply organizations and shops to discard of off-specification, expired, and excess materials with hazardous components.

Although this option may work best for process-related hazardous waste, DRMO contracts may be an effective hazardous IDW management option in special circumstances. In the circumstance where specimen collection activities recover relatively "pure" hazardous substances (e.g., container specimen waste, light or dense non-aqueous phase liquids [LNAPL, DNAPL], etc.), the DRMO method may provide a feasible means of handling it. Resembling hazardous wastes normally handled by DRMO, hazardous IDW may be disposed under an existing contract.

Otherwise, hazardous IDW bound for off-site disposal may be best handled by a hazardous waste contractor. Hazardous waste contractors with the knowledge and means to handle, test, and transport the IDW to the proper facility may be able to routinely provide the necessary services critical to successful hazardous IDW management. Termed transporters by RCRA Subtitle C, contractors engaged in off-site transportation of hazardous waste must comply with strict requirements. The transporter must have a USEPA identification number and comply with the appropriate manifest system (Wentz, 1989:79,80).

Those RPMs desiring an expedient means of disposing of liquid IDW off site may take advantage of an opportunity found RCRA. RCRA's Domestic Sewage Exclusion (DSE) provides a convenient solid waste management option, normally reserved for non-hazardous liquids, to deal with liquid IDW that has a hazardous component. Subject to prior approval by the local Publicly-Owned Treatment Works (POTW), certain types and concentrations of RCRA hazardous liquid IDW may be disposed in the sanitary sewer system under an existing National Pollution Discharge Elimination System (NPDES) permit authority. The method presumes: 1) the hazardous IDW component is treatable by conventional wastewater treatment methods, 2) hazardous IDW characteristics are monitored and recorded prior to each disposal event, and 3) that verifiable consent was requested and granted by the treatment facility authority before each disposal event (USEPA, 1986a:1-5).

Off-site IDW management options almost always involve landfill disposal. As indicated by the frequent choice of landfilling as a means for final disposition, off-site disposal of IDW ranks high with RPMs. Hazardous IDW sent off site must go to a RCRA-approved landfill or TSD facility. The facility receiving hazardous IDW is strictly regulated. According to RCRA, TSD receiving hazardous waste must have a USEPA identification number, the ability to identify and handle hazardous waste, and the means to verify that operations conform to standards. TSD facilities must also maintain records to adequately account for the waste delivered to the facility (Wentz, 1989:89). Use of such means may provide RPMs with the accountability required by RCRA to meet "cradle-to-grave" management requirements for off-site disposal of hazardous IDW.

Summary

Interviewing was used to collect data about the practical aspects of IDW management. Telephone interviews were conducted according to the method prescribed in chapter three. Interview information was noted and recorded with the assurance that interviewer responses would not be attributed. Interviewing was completed over a five week period.

The data collected from the interviews were edited and grouped. Then, transcribed interview data and literature review information was discussed. Where applicable, the content of the interview data was compared with literature review information.

The discussions were then used to deduce the findings of this study. In general, the findings were supported by the collected information and provided a basis upon which to answer the questions posed by this study.

V. Conclusions and Recommendations

Introduction

This study's purpose was to identify the status and to evaluate the need to improve IDW management. In order to develop an understanding of the status of IDW management, guidance and regulations related to IDW management were researched by means of a literature review. Interviews conducted among individuals actively engaged in IDW generation activities uncovered needed improvements. An analysis of the findings from the literature review and interviews revealed that a variety of IDW management options are currently being applied with varying degrees of success. The following sections offer conclusions and recommendations about the status of IDW management and the means to improve it.

Conclusions

Based upon the results of this study, it is concluded that USAF RPMs are actively engaged in IDW management during IRP investigations. Improved IDW management, especially with regard to minimization, may reduce the amount of IDW generated and better assure that critical protection and compliance issues are addressed. Improvements to IDW management depend upon an increased awareness by RPMs of IDW management requirements and the options available to meet them.

Recognition and development of IDW management plans may be viewed by some as an addition to an already long list of IRP responsibilities. Indeed, IDW management requires an effort to properly select and implement the appropriate option at the right time. However, the pay-back may be realized by reduced IDW and simplified handling of that which is generated. Improperly managed waste, especially that with a hazardous component, has the potential to attract unwanted regulator attention, jeopardize human health, or result in costly noncompliance penalties. By adopting IDW management at the outset of IRP activities, RPMs have the opportunity to reduce IDW generation and anticipate its fate.

An assessment of the current status of IDW management led to the conclusion that improvements are needed in IDW planning. Possibly due to an attitude that "more is better", overzealous specimen collection activities result in accumulations of IDW. RPMs who neglect to plan for the consequences of unbridled specimen collection may later be saddled with large amounts of IDW. Through proper planning, IDW management is improved in that it provides RPMs with an opportunity to balance specimen collection needs with IDW management requirements.

It is further concluded that guidance documents are needed to guide RPM's IDW management efforts. IDW management is impaired by the inadequacy and unavailability of current guidance. Presently, IDW management guidance is comprised of two USEPA publications. The publications are limited in scope and detail in that they cover only one IRP stage (SI) and offer only generalized IDW management options. This limitation may lead some RPMs to be over conservative in their selection of management options.

Guidance was also limited in terms of its availability. As disclosed by this study, RPMs faced with IDW were largely unaware of any formal guidance. Consequently, RPMs used methods adapted from hazardous waste management guidance, state waste management policy, and environmental remediation project contract language. This limitation may lead to RPMs adopting, by trial and error, inefficient methods of IDW management.

Without guidance, RPMs tended to manage IDW in an overly-conservative manner by exercising tight control over it. Likely prejudiced by the notion that a hazardous substance-contaminated site must yield hazardous IDW, some RPMs reacted to all IDW as if it posed a significant hazard. Most adopted extraordinary steps to isolate it. Consequently hundreds of drums and several large tanks containing IDW now reside indefinitely at several USAF bases. While laudable in terms of protection, overly-conservative IDW management decisions must be avoided. Such decisions may invoke regulations that are inappropriate to the actual risk and incur additional costs which could be better spent on higher priority remediation activities.

Finally, this research also led to the conclusion that existing IDW management options are under-utilized. Appropriate IDW management options must provide an adequate level of protection and compliance commensurate with the characteristics of IDW. Current practice appears to rely too heavily upon off-site disposal with little regard to IDW characteristics.

Recommendations

The foremost recommendation evolving from this study is that IDW management guidance be developed for use by RPMs. New guidance may draw on existing USEPA guidance, federal environmental law, DOD/USAF waste management policy and the experiences of base-level RPMs as recorded in this study. Developed as a supplement to existing DOD and USAF IRP guidance and handbook publications, IDW management guidance may be easily integrated into existing editions. Integration of guidance would allow individuals who are receiving IRP guidance and training to be alerted to IDW management issues. The opportunities to minimize IDW generation may be addressed in the IRP investigation planning process and IDW handling decisions may receive timely attention.

Furthermore, it is recommended that base-level RPMs recognize IDW's potential to cause significant disruption to their IRP and that they continue to take steps to manage it. Until such time that improved guidance is available, it is recommended that RPMs take the initiative to implement the necessary management options appropriate to their specific circumstances. This may be accomplished through contact with the scores of RPMs currently engaged in IRP activities. In this way, the practical experiences of those successfully managing IDW may benefit others.

Finally, it is recommended that future research into IDW management address the question of IDW minimization. Specifically, methods of reducing data required to characterize a site should be investigated. The research will likely involve the participation of base-level IRP managers, USEPA and state environmental regulators, and contractors experienced in remedial investigations. In addition, the efficacy of nonintrusive methods such as infrared photography, ground-penetrating radar, and electromagnetic detection methods to meet data requirements should be examined.

In summary, USAF continues to demonstrate leadership in its commitment to clean up its bases. With other DOD services and agencies close behind, the IRP investigative efforts necessary to complete this task will produce vast amounts of IDW. By development of comprehensive IDW guidance, base-level IRP personnel will be better equipped to protect human health and the environment while complying with environmental regulations.

Appendix A: Telephone Interview Questionnaire

THESIS TELEPHONE QUESTIONNAIRE | Questionnaire index #____ (for requestor use only)

REQUESTOR: Barry C. Mountain, 2950 "P" Street, AFIT/ENV Box 4119
WPAFB, OH 45433-7765 DSN: 785-2998 (vox); 986-4055 (fax)

INTRODUCTION

Investigation-Derived Waste (IDW) is defined as the excess solids, liquids, and disposable supplies generated by intrusive physical sampling. Intrusive physical sampling is often used in Installation Restoration Program (IRP) Site Inspections (SI) and Remedial Investigations (RI) to characterize sites believed to be contaminated with hazardous substances. Because large amounts of data are needed to characterize sites, the potential to generate large quantities of IDW is significant.

The purpose of the following questions is to collect information about you and your experience with IDW. The information you share will help to put IDW in proper perspective and to determine what, if any, management is appropriate.

BEGIN INTERVIEW

CLASSIFICATION QUESTIONS (Respondent)

Please state your occupational TITLE: ______________________

Please state the number of YEARS you have performed IRP duties. ___YRS

Are you the Remedial Project Manager (RPM) at the base? Yes [ ] No [ ]

Please state the number of YEARS you have performed RPM duties. ___YRS

CLASSIFICATION QUESTIONS (Facility)

Approximately how long have you had an active IRP at your base? ___YRS

Is your base listed on United States Environmental Protection Agency's (USEPA) National Priority List (NPL)? YES [ ] or NO [ ]

Please estimate the number of your IRP sites that have reached:

PA/SI _____ RI/FS _____ RD/RA _____

Please list the Contaminants of Concern (COC) found at your base:

______________, ______________, ______________, ______________

______________, ______________, ______________, ______________

DISCUSSION QUESTIONS

Please take the time to develop a response to the following questions prior to our telephone conversation.

1. Have you obtained guidance about IDW management? If so, from whom? (A copy of the guidance would be very helpful).
2. What methods are used to collect samples? Do the methods generate IDW? If so, how much and what kind? Are there any hazardous materials in it? How do you know? Do you consider IDW minimization?

(more)

DISCUSSION QUESTIONS (continued)

3. If SI and RI field work is contracted, is the contractor obligated to manage IDW? (A copy of any contract language that specifically deals with IDW management would be very helpful). If so, what do they do? If not, what do you do?
4. Have IDW generation or management activities caused your base to receive "bad" press, Notices of Violation (NOV), or additional regulator attention? If so, please explain.
5. Is IDW a problem? If so, why and what do you suggest be done?

==

END INTERVIEW

==

To avoid taking up extra time during the telephone interview please fill in the information requested below and return it by fax to:
BARRY MOUNTAIN, AFIT/ENV W-P AFB, OH   DSN 986-4055(fax) 785-2998(vox)

REGULATORY AND TECHNICAL SUPPORT

The USAF, as the lead agency, is often supported in their remedial efforts by environmental regulators. If this is true at your base, please provide information about the agencies that support remedial efforts for your base below:

AGENCY	ADDRESS	CONTACT	TELEPHONE
________	____________________	________	______
________	____________________	________	______

Service centers develop and manage environmental remediation contracts for a variety of consultant and construction services useful to IRP efforts. If this is true for your base, please provide information about the service center(s) that you use.

CENTER	ADDRESS	CONTACT	TELEPHONE
________	____________________	________	______

==

ADMINISTRATIVE QUESTIONS

Respondent name --------------------> ______________________________
(last), (first) (MI)

Respondent mailing address

____
(organization, building, room)

____
(base, state, ZIP code)

Respondent telephone numbers
VOX | FAX
DSN: __________ | __________
COMM: ( ) __________ | ( ) __________

Are you or your organization listed on DDN WANG E-mail? Yes [ ] No [ ]

==

THANKS AGAIN!

Thank you for your participation. An analysis of the information collected by this questionnaire will be available on or about 21 September 1993. If you are interested in receiving a copy, please say so during the course of our upcoming telephone conversation.

Appendix B: Interview Transcription Form

THESIS TELEPHONE QUESTIONNAIRE RESPONSE TRANSCRIPTION

RESPONSE DATE: ____ May 93

RESPONDENT: ______________ BASE: __________ NPL? YES NO

TELEPHONE: DSN________________(vox) DSN________________(fax)

Has respondent returned page two of the questionnaire? Y N

==

START: _______

SITES/STAGE/CONTAMINANTS:

GUIDANCE (copies? ___)/CONTRACT LANGUAGE (copies? ___):

METHODS/QUANTITIES/MINIMIZATION:

FIELD SCREENING/INITIAL HANDLING/FINAL DISPOSITION:

PRESS/VIOLATIONS/ATTENTION:

SUGGESTIONS:

END: _______

Appendix C: Glossary of Acronyms

The following acronyms are found within the text of this study. The definitions conform to common usage as of the date of this study.

AFR -- Air Force Regulation

AOC -- Area of Contamination

ARAR -- Applicable or Relevant and Appropriate Requirements

BTX -- Benzene, Toluene, Xylene

CERCLA -- Comprehensive Environmental Response, Compensation, and Liability Act

CFR -- Code of Federal Regulations

COC -- Contaminants of Concern

CWA -- Clean Water Act

DDN -- Defense Data Network

DE -- Disposable Equipment

DERA -- Defense Environmental Restoration Account

DERP -- Defense Environmental Restoration Program

DNAPL -- Dense Non-Aqueous Phase Liquids

DOD -- Department of Defense

DOT -- Department of Transportation

DRMO -- Defense Reutilization and Marketing Organization

DSE -- Domestic Sewage Exclusion

DSN -- Defense Switching Network

ECAMP -- Environmental Compliance Assessment and Management Program

FID -- Flame-Ionizing Detector

FS -- Feasibility Study

GC -- Gas Chromatograph

HMTA -- Hazardous Material Transportation Act

HSWA -- Hazardous and Solid Waste Amendments

IDW -- Investigation-Derived Waste

IG -- Inspector General

IRP -- Installation Restoration Program

LDR -- Land Disposal Restrictions

LNAPL -- Light Non-Aqueous Phase Liquid

NCP -- National Contingency Plan

NOV -- Notice of Violation

P3P -- Pollution Prevention Program Policy

PA -- Preliminary Assessment

PCB -- Polychlorinated Biphenyl

PID -- Photo-Ionizing Detector

POTW -- Publicly-Owned Treatment Works

PPE -- Personal Protective Equipment

RA -- Remedial Action

RCRA -- Resource Conservation and Recovery Act

RD -- Remedial Design

RI -- Remedial Investigation

RPM -- Remedial Project Manager

SC -- Site Closure

SI -- Site Inspection

TCE -- Trichloroethylene

TDU -- Treatment and Disposal Units

TPH -- Total Petroleum Hydrocarbons

TSCA -- Toxic Substances Control Act

TSD -- Treatment, Storage, and Disposal

USACE -- United States Army Corps of Engineers

USAF -- United States Air Force

USEPA -- United States Environmental Protection Agency

WWTP -- Wastewater Treatment Plant

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Vita

Barry Charles Mountain was born 26 March 1948 in Evanston, Illinois. He graduated from Severson High School at Stanley, North Dakota in 1966. Upon induction into the United States Army that same year, Mr. Mountain served as a radio operator with the artillery at Ft. Sill, Oklahoma and with several advisory teams attached to the 9th Infantry Division in South Vietnam. Following military service, Mr. Mountain spent several years as a portrait photographer, personnel specialist, clothing salesman, and roughneck. After marrying Susan Quammen in 1972, he settled in Denver and started college. His graduation from the University of Colorado with a bachelor's degree in civil and environmental engineering in December 1978 led to relocation to Wyoming. There, he worked at several consultant and government engineering jobs. Mr. Mountain joined the 90th Civil Engineering Squadron at F.E. Warren AFB, Wyoming in 1989. Serving as the chief of the environmental restoration section (90 SG/CEVR), he was responsible for the conduct and management of the Installation Restoration Program (IRP) until entering the School of Engineering, Air Force Institute of Technology in May 1992.

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13. ABSTRACT *(Maximum 200 words)*

USAF is dedicated to the clean up of past releases of hazardous substances at its bases under the Installation Restoration Program (IRP). Clean up decisions are based upon data produced from investigations. Large amounts of waste may be derived from investigations. Investigation-derived waste (IDW), especially that with a hazardous component, may pose significant health protection and regulatory compliance problems if neglected. This study identifies the status and the need for improvement of IDW management to avoid those problems.

Information on the background of IDW management was collected through a review of environmental laws, waste management regulations, and existing guidance. Practical IDW management information was gleaned from conversations with IRP managers at twelve USAF bases around the country.

This study revealed that IDW management needs improvement. All bases acknowledged IDW concerns and have adopted various methods to deal with them. However, current methods appear to rely more upon expediency rather than permanence. This study showed that critical protection and compliance issues are being overlooked. Development of specific IDW management guidance may better assure that critical issues are addressed.

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